The Importance of Learning Styles to Form More Successful Cooperative Groups in Physics Course

Fatih ÖNDER
İlhan SILAY

Dokuz Eylül University
Buca Faculty of Education
Izmir, TURKEY

(Received: 05.01.2016, Accepted: 01.03.2016)

***DOI**: 10.20308/ejpe.48367*

Abstract
This research aims to determine the effectiveness of cooperative groups, organized according to learning styles, on students' physics success. The research was designed according to non-equivalent control group design. In the experimental group, the students were assigned into cooperative groups heterogeneously according to their learning styles and in the control group the students were assigned into cooperative groups according to their academic success. At the end of the research, it was seen that the students in the experimental group were more successful than the students in the control group. In addition, it was determined that there was no significant difference on the experimental group students' success according to their learning styles, but that the auditory students were more successful than the visual and kinesthetic ones in the control group.
Key words: cooperative learning; learning styles**;** mechanic; physics success

INTRODUCTION

Each person has his/her own way of learning. Some people learn better by watching, some by listening and some by touching (Dodge, Colker & Heroman, 2002). These differences in people's learning are explained by learning styles. "Learning style is the way in which each person absorbs and retains information and/ or skills" (Dunn, 1984 p.12). As the path each person follows while learning is different, such differences need to be taken into consideration when establishing an effective learning environment.

A learning environment can be categorized as one of three types: competitive, individual and cooperative (Johnson & Johnson, 2000; Johnson, Johnson & Holubec, 1994). In a competitive learning environment, students try to be the best while, in an individual learning environment, students study independently from the others according to their own, individual aims. In a cooperative learning environment, however, students study in heterogeneous groups, in accordance with the group goal (Marr, 1997). It is difficult to organize competitive and individual learning environments based upon learning styles. This is because this condition requires the use of different teaching methods for each student with a different learning style. In addition, using the cooperative learning method, which is one of the active learning approaches, in a cooperative learning environment, can be helpful for the educators. Because cooperative learning has an appropriate structure for organize the learning environment according to students' learning styles.

** This study is derived from the first author's doctoral dissertation.*

Cooperative learning can be defined as students working together by helping each other in small groups in accordance with a common aim (Açıkgöz, 2003). Importantly, however, although cooperative learning is group work, not all group work is cooperative learning. Group work is cooperative learning only if it has fundamental features such as positive dependency, individual responsibility, face-to-face communication, social abilities and group process (Johnson & Johnson, 1999).

Johnson, Johnson & Holubec (1998), defined four different learning group types: the pseudo learning group, the traditional learning group, the cooperative learning group and the high-performance cooperative learning group. Among these, the high-performance cooperative learning group is the one that has the best efficiency. The most important characteristic of this group's structure is the high level of group members' willingness to working together, and the commitment of the members to each other and to the group's success. Therefore, in the research, an effort was made to increase the willingness to commit to the group and work together. To enable this, the preference was to form heterogeneous groups according to learning styles and to match the students with roles suiting their learning styles.

Forming Cooperative Groups According to the Learning Styles

"Elements of learning style appeared in the research literature as early as 1892" (Fatt, 2000 p. 32). Indeed, Hall and Moseley (2005) determined that 71 learning styles models were published between 1902 and 2002. In this research, however, the VAK (Visual, Auditory, and Kinesthetic) model was focused on. This model refers to the sensory channels through which people take in and process information (Avis, Fisher & Thompson, 2009; Wills & Hodson, 1999). The VAK model is a perceptual, instructional preference model that categorizes learning by sensory preferences (Miller, 2001).

"The individual learning style has both strengths and weaknesses depending on what is to be learnt and how" (Heffler, 2001 p.308) and, for visual learners, information is best obtained by reading and looking at visual materials (Doyle & Rutherford, 1984; Felder & Silverman, 1988; Lincoln & Rademacher, 2006). Visual learners are the silent students in the learning environment, they study by writing, and they learn more easily by looking at diagrams; figures and charts (Boydak, 2001). In contrast, auditory learners are talkative students, and their communicative abilities are strong (Boydak, 2001), they learn best by listening (Doyle & Rutherford, 1984) and solve problems by talking about them (Dodge, Colker & Heroman, 2002). Kinesthetic learners learn by using the materials directly (Doyle & Rutherford, 1984); they are the active students of the learning atmosphere and feel disturbed in environments where they have to stay immobile for a long time (Boydak, 2001).

Given that the group members interact with each other in cooperative groups, it is possible to create an atmosphere in which students who have different learning styles interact and help one another's learning by arranging the groups heterogeneously according to student's learning styles. This group structure enables students who have different learning styles to share the things they learn and see the events from each other's perspectives. In this way, both the willingness to study together can be increased, and the students with different styles can be prevented from learning less than the others.

To increase group dependency and to activate the method in cooperative groups, a role must be given to every group member. When considering students with different characteristics according to their learning styles, it should be understood that they cannot take on the responsibilities of random roles in the cooperative learning process. In such a case, since the students would perform roles that are inappropriate for them, they would develop both a negative attitude towards the learning process, and would not benefit enough from the

process. Thus, the students need to be matched with roles suitable to their learning styles. Because forming groups heterogeneously in accordance with the learning styles produces a group with students from each learning style, it is possible to appoint a suitable person to each role. In case one of the group members is not available, the other students will have to take on responsibilities, which are not appropriate for them, resulting in a role that they do not like, and leading to dependency of the group members on one another to grow.

In this study, the students in the groups studied together to produce common answers to the questions on their worksheets; the students with different learning styles were then given roles as set out below.

Visual students were responsible to:

- transferring the group's work into a paper
- drawing the experiment plan and showing the data on a table.

Auditory students were responsible to:

- explaining the answers to the questions in the worksheets to the class
- presenting the experiment results to the class

Kinesthetic students were responsible to:

- solving the problems on the board
- preparing the experiment equipment and establishing the experiment mechanism.

Learning styles are one of the most important variables that affect students' academic achievement. There are some studies in the literature that shows students' achievement is significantly different according to their learning styles (Cano, 1999, Aripin et al., 2008, Tatar, Tüysüz & İlhan, 2008). Bacon (2004) states that students' learning is significantly improved if their learning styles are correctly matched to the learning environment. Brudnell and Carpenter (1990) found that the students taught with strategies appropriate for their learning styles were more successful than the others. Miller (2001) states that students' motivation increases when the teaching process is appropriate to the student learning style. Dunn et al (1990) also identified the fact that students who were taught in a way appropriate to their learning style preferences were more successful than others. Therefore, this study aims to organize the cooperative learning groups according to students' learning styles and to investigate the impact of this method on the students' physics success.

Research questions

What are the effects of cooperative learning groups which are organized according to learning styles on students' physics lesson success?

METHODOLOGY

Research Design

This study was designed according to non-equivalent control group design with pretest and posttest. In the non-equivalent control group design, an experimental group is compared with a control group by using pretest and posttest measures. This design is similar with pretest-posttest control group design. But in a non-equivalent design participants are not assign the treatment conditions at random (Reichadt, 2009).

Participants

The research was carried out with 48 undergraduates students (28 females and 20 males) enrolled in Physics-I course in Dokuz Eylul University, Education Faculty of Buca. The

students were divided into two groups based on learning styles and the experimental and control group was formed.

Instruments

Perceptional Learning Styles Inventory (PLSI)

The learning styles scale separates the students according to their learning styles into three groups: visual, auditory and kinesthetic learners. The scale, which was prepared as a five-point Likert scale, was applied to 351 students in the Education Faculty of Buca. To determine the validity of the PLSI, it was subjected to a factor analysis and a discriminant analysis. With factor analysis (rotated by varimax), it was determined that the total variance of the scale explained the 64% gathered under three factors, and the Cronbach Alpha reliability was counted as 0.74. Factor loadings and Cronbach Alpha reliability coefficients of each factor can be seen in Table 1.

Table 1. *PLSI Varimax components matrix*

Item	Visual	Auitory	Kinesitetic
1	.85		
6	.84		
4	.75		
7	.72		
11	.40		
2		.88	
8		.87	
5		.68	
12		.63	
13		.54	
9			.89
3			.76
10			.75
15			.57
14			.54
Cronbach's α	.72	.78	.77

KMO: 0.764; Barlett's test p< .05; total variance explained: 64%

The discriminant analysis showed that students can be separated into groups according to their learning styles by using PLSI at a significant level (Table 2). The discriminant functions are derived as follows:

$$Y_1 = -39{,}51 + 2{,}02X_1 + 1{,}52X_2 + 1{,}71X_3 \text{ (Auditory score)} \quad (1)$$

$$Y_2 = -44{,}31 + 1{,}22X_1 + 2{,}51X_2 + 1{,}83X_3 \text{ (Visual score)} \quad (2)$$

$$Y_3 = -42{,}08 + 1{,}19X_1 + 1{,}45X_2 + 2{,}57X_3 \text{ (Kinesthetic score)} \quad (3)$$

The total point taken from auditory items in the PLSI is X_1, total point from visual items is X_2, and from kinesthetic items is X_3. The highest score from the discriminant functions shows the student's dominant learning style.

Table 2. *The results of Wilks' Lambda test*

Function	Wilks' Lambda	Chi-Square	df	p
1-2	.20	162.34	6	0.00*
2	.60	52.10	2	0.00*

*p< .05

Mechanical Units Achievement Test (MUAT)

The MUAT, developed by the researchers, contains questions relating to Particle Dynamics I, Particle Dynamics II, and Work and Energy topics. The MUAT was applied to 254 students in the DEU Education Faculty of Buca. The KR-20 reliability coefficient of the MUAT was determined to be 0.82. MUAT consists of 25 multiple-choice items. Each correct choice is given 4 points, and an incorrect choice is scored as zero. Thus, the scores of the MUAT range from 0 to 100. Difficulty and discrimination indexes of each item can be seen in Figure 1. Construct validity of the MUAT is provided through the feedback received from four experts in the field.

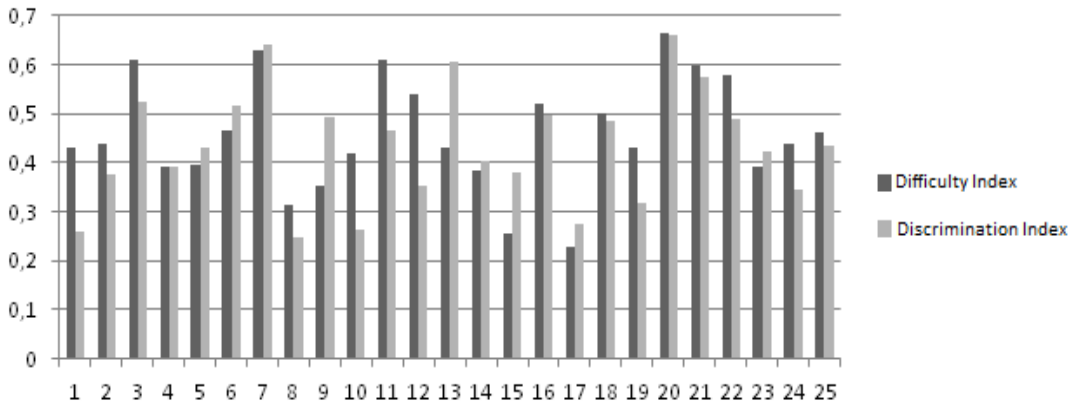

Figure 1. *Difficulty and Discrimination Indexes of MUAT*

Procedure

This research was carried out for seven weeks. Before the research, PLSI and MUAT were applied to the students in order to define the experimental group and the control group. In the research, the Student Teams Achievement Division technique, developed by Slavin (1978), was used in both experimental and control groups. In the experimental group, the cooperative groups were formed heterogeneously according to students' learning styles, and four members were appointed to each group (there were more visual students than others, so there were two visual student in each group). In the control group, the cooperative groups were formed heterogeneously according to students' academic success depending on their University Entrance Exam points, and four members were appointed to each group.

After the groups had been formed, it was time to determine the roles of the students in the groups. The pre-determined roles were written on the board, and the duties and responsibilities of the students were announced. At the end of the procedure, the students in the experimental group were matched with roles suitable to their learning styles, but the ones in the control group were matched with roles that were not suitable to their learning styles.

Each unit began with a brief presentation of each topic's important points. After the presentation, which lasted about twenty minutes, only two worksheets were given to the groups in order to provide interdependence. To find solutions to the questions on the worksheets, all of the students in the group worked together for forty minutes. The groups

were asked to present their answers to the questions on the worksheets to the class in the next thirty minutes. According to their learning styles, students took the following roles in this process. The visual students composed the group report by transferring the answers into written, diagrammatic and graphic forms. The auditory students presented those answers that required verbal explanations to the class, and the kinesthetic students presented the answers that required mathematical operations on the board.

The ninety-minute lesson was conducted in the laboratory during the next period. A problem situation relating to that week's unit was given to the groups at the beginning of the lesson. The groups were asked to design an experiment in order to answer the problem situation. Students worked to design the experiment, find the equipment and form the experimental set up in thirty minutes. They then collected the data and composed their results during the next forty minutes. During the last twenty minutes of the lesson, the groups presented their results to the class. According to their learning styles, the students performed their roles as follows. The visual students drew the experimental set up and prepared the data tables. The kinesthetic students found the equipment and composed the experimental set up. The auditory students presented their group's experimental set up, data and results to the class. The lessons in the control group were conducted following the same process as with the experimental group, but the students were mismatched with roles according to their learning styles.

According to Slavin (1996), "there are three basic concepts that are central to all Student Team Learning methods: team rewards, individual accountability, and equal opportunities for success" (p.21). To enable these conditions in the research, at the end of each unit, a thirty-minute quiz was applied to the control and experimental groups. The averages of the quiz points of the group members were calculated and five extra points were given to the group, which had the highest average. This was announced to the students one week before the application, and they were informed that their evaluations at the end of the semester would be calculated based on the following criteria: 60% from the MUAT, 20% from the worksheets, 15% from the quizzes and 5% from extra points. At the end of all the units, the experimental and control groups came together, and the research ended with the application of the achievement test as a posttest in the same lesson hour.

RESULTS

Table 3 shows the means and standard deviations of the pretest and posttest scores of the experimental and control group students.

Table 3. *Experiment and control groups' pretest and posttest results*

Test	Experiment Group (n=24)		Control Group (n=24)	
	M	sd	M	sd
Pretest	33.58	6.70	32.91	7.78
Posttest	70.08	6.68	62.38	9.88

It is seen that in Table 3, achievement test scores of the students in both experimental and control group increased. Also post-test scores of the students in the experimental group are higher than students in the control group. Split-plot ANOVA (SPANOVA) was conducted to assess the impact of two different interventions on students' scores on the achievement test, across two-times period (pre-intervention, post-intervention).

Table 4. *SPANOVA results of MUAT's pretest and posttest scores*

Source	sd	df	MS	F	p
Group (experiment-control)	748.167	1	748.167	4.133	.048*
Error a	8327.667	46	181.036		
Test (pretest-posttest)	9922.667	1	9922.667	265.786	.000*
Group x Test	1176.000	1	1176.000	31.500	.000*
Error b	1717.333	46	37.333		

*p<.05

According to results of the analysis, it is seen that the organization of cooperative groups based on learning styles or academic achievement has different effects on increasing achievement test scores of students ($F_{(1,46)} = 31.50$, $p < .05$). Taking into account the data in Table 3, it can be said that the application in the experiment group is more effective than the application in the control group. In addition, SPANOVA test results indicate a significant increase in the post-test scores of students in both the experiment and the control group in relation to their pretest scores ($F_{(1,46)} = 265.79$, $p < .05$). Also the main effect comparing the two types of intervention was significant ($F_{(1,46)} = 4.133$, $p < .05$), suggesting difference in the effectiveness of two approaches.

The MUAT scores according to learning styles

Because the scores from the sub-dimensions of the learning styles scale do not show normal distribution, non-parametric tests were used in the following part of the study.

The means and the standard deviations of the pretest and posttest applications of the MUAT according to the learning styles are shown in Table 5. The Kruskal-Wallis Test was used in order to determine whether or not there was a significant difference in the pre-test scores based on the learning styles.

Table 5. *MUAT scores according to learning styles*

Test	Experimental Group						Control Group					
	Visual (n=10)		Auditory (n=8)		Kinesthetic (n=6)		Visual (n=9)		Auditory (n=9)		Kinesthetic (n=6)	
	M	sd	M	sd	M	sd	M	sd	M	sd	M	sd
Pretest	33.60	6.85	35.50	3.96	31.50	9.27	35.78	6.96	32.44	8.41	30.50	7.90
Posttest	68.90	6.07	72.50	7.41	68.00	7.15	61.55	8.87	70.67	6.16	55.00	8.74

Test results showed no significant difference according to the learning styles in the pre-test scores of students in the experimental and control groups (Table 6).

Table 6. *Kruskal Wallis test for pre-test scores*

Group	Learning Style	n	Mean Rank	df	χ^2	p
Experiment	Visual	10	12.40	2	1.92	.383
	Auditory	8	14.81			
	Kinesthetic	6	9.58			
Control	Visual	9	14.78	2	1.52	.379
	Auditory	9	12.06			
	Kinesthetic	6	9.75			

The Kruskal-Wallis Test was used again to compare the post-test scores to determine whether or not there was a significant difference according to the learning styles of students in the experimental and control groups. As can be seen from the results of the test, no significant difference according to the learning styles was found between the post-test scores of students in the experimental group. However, the differences according to learning styles between the post-test scores of students in the control group were found to be significant (Table 7).

Table 7. *Kruskal Wallis Test scores according to learning styles*

Group	Learning Style	n	Mean Rank	df	χ^2	p
Experiment	Visual	10	11.85	2	.98	.612
	Auditory	8	14.44			
	Kinesthetic	6	11.00			
Control	Visual	9	11.17	2	9.61	.008*
	Auditory	9	17.18			
	Kinesthetic	6	6.58			

*p<.05

In order to determine in which groups this difference occurs, the Mann–Whitney U test was used to compare the post-test scores of students in the control group (Table 8). The U test results indicate that, in the control group, auditory students were much more successful than visual and kinesthetic students. The post-test scores of auditory and kinesthetic students showed no significant difference.

Table 8. *Mann Witney U test results for control group*

Learning Style	n	Mean Rank	Sum of Ranks	U	p
Visual	9	6.78	61.00	16.00	.03*
Auditory	9	12.22	110.00		
Visual	9	9.59	84.50	14.50	.14
Kinesthetic	6	5.92	35.50		
Auditory	9	10.56	95.00	4.00	.01*
Kinesthetic	6	4.17	25.00		

*p<.05

In order to determine the relationship between students' learning styles and the MUAT scores, Kendall's tau and Spearman's rho values were calculated using rank correlation analysis. Table 9 shows the results of the correlation analysis. As can be seen from the results, a significantly positive relationship exists between the scores that the control group students obtained in the auditory dimension of the learning styles scale and their MUAT scores. On the other hand, there seems to be only a significant negative relationship between the scores obtained from the kinesthetic dimension of the scale and the MUAT scores. In other words, the successes of the students increase with their auditory characteristics, while their success decreases as their kinesthetic characteristics increase. In the experimental group, no significant relationship was found between learning styles and success.

Table 9. *Correlation analysis between learning styles and MUAT Scores*

Group	Learning Style	tau	p	rho	p
Control	Visual	- .065	.669	-.085	.694
	Auditory	.566*	.000	.720*	.000*
	Kinesthetic	-.519*	.001	-.698*	.000*
Experiment	Visual	.094	.555	.120	.577
	Auditory	.209	.186	.273	.197
	Kinesthetic	.092	.559	.122	.572

*p<.05

DISCUSSION

This research has shown that, in increasing the success of students in the physics course, the cooperative groups formed according to their learning styles are more effective than the cooperative groups formed according to their academic success. Throughout the research, students with different learning styles in the experimental group were enabled to interact with one another by forming cooperative groups heterogeneously according to the learning styles. In this way, students with different learning styles had the chance of sharing the things they learnt and seeing the events from their friends' perspectives. In addition to this, as this group structure enables students of all three styles to be in the same group, we had the opportunity of matching students with suitable roles for their individual features. Giving responsible roles to the students in the group work is one of the most important elements of the cooperative learning method. Doing so increases the dependence of students on each other. Johnson, Johnson & Holubec (1994), call this situation of giving complementary roles to each member of group positive role interdependence. Since the students with different learning styles may possess different characteristics, matching the students with the roles should not be done randomly. At this point, the importance of arranging groups heterogeneously according to learning styles becomes apparent because arranging groups as such will make it possible to have students with different styles within the same group. Thus, each student should be assigned roles suitable to his or her learning style. In the cases when this heterogeneous structure is not taken into consideration, it is possible that several students with the same learning style are in the same group. In such cases, many students may volunteer for certain roles, while no students will undertake others. In other words, the positive dependence among the members of the group will be jeopardized at the beginning of the process.

However, the findings have shown that the academic success of the students in the experimental group shows no significant difference according to the learning styles, but the auditory students in the control group were more successful than the visual and kinesthetic ones. From this finding, it can be inferred that the students in the control group could not benefit from the learning process equally. A similar result showing that the students cannot benefit equally according to their learning styles from the cooperative learning method is found by Gökdağ (2004). When Gökdağ (2004) compared the students' achievement after the cooperative learning process, she determined that visual learners are more successful than auditory and kinesthetic learners. The compliance between learning environment and students' learning styles can be shown as a main reason for this situation. It is not possible to ensure that students from all three styles will be in the same group when forming the cooperative group according to their academic success. Because of this, while some students have the chance of taking on responsibilities appropriate to their learning styles, some do not. This situation prevents some students from benefiting from the learning process equally, and it negatively affects their success at the end of the process.

This research shows no significant difference between students' success in physics lessons based on their learning styles in the experimental group, which is organized according to learning style. In this case, it can be said that the students with different learning styles equally benefit from the cooperative learning process in the experimental group. Another interesting finding from the research is revealed when the relationship between students' PLSI and MUAT scores are analyzed. In the control group, students' MUAT scores were directly proportional to their auditory scores and inversely proportional to their kinesthetic scores. In other words, a student's success increases when his /her auditory learning style becomes more dominant and decreases when his/her kinesthetic learning style becomes more dominant. In this context, it can be said that auditory learners benefit most in the cooperative groups organized by taking into account academic success. Alfonseca et al. (2006) and Hench (1993) emphasize that learning styles affect the performance of the students when working together. Therefore, students' learning characteristics should be taken into consideration, and the process should be planned according to these characteristics even when an effective method such as the cooperative learning method is used.

REFERENCES

Açıkgöz, K. Ü. (2003). *Aktif öğrenme*. İzmir: Eğitim Dünyası Yayınları.

Aripin, R., Mahmood, Z., Rohaızad, R., Yeop, U., & Anuar M. (2008**).** Students' Learning Styles and Academic Performance. 22. Annual SAS Malaysia Forum, Kuala Lumpur, Malezya.

Avis, J., Fisher, R., & Thompson, R. (2009). *Teaching in lifelong learning.* Maidenhead: Open University Pres.

Alfonseca, E., Carro, R. M., Martin, E., Ortigosa, A. & Paredes, P. (2006). The impact of learning styles on student grouping for collaborative learning: a case study. *User Modeling and User-Adapted Interaction*, 16(3-4), 377-401.

Bacon, D. R. (2004). An Examination of Two Learning Style Measures and Their Association with Business Learning. *Journal of Education for Business*. 79(4), 205-208.

Boydak, A. H. (2001). *Öğrenme stilleri*. İstanbul: Beyaz Yayınları.

Brudnell, I., ve Carpenter, C. S. (1990). Adult Learning Styles and Attitudes toward Computer Assisted Instruction. *Journal of Nursing Education***.** 29, 79-83.

Cano, J. (1999). The relationship between learning style, academic major, and academic performance of college students. *Journal of Agricultural Education*, 40 (1), 30-37.

Dodge, D.T., Colker, L.J., & Heroman, C. (2002). *The creative curriculum for preschool (4th ed.)*. Washington, DC: Teaching Strategies, Inc.

Doyle, W., & Rutherford, B. (1984). Classroom research on matching learning and teaching styles. *Theory into Practice*, 23, 20-25.

Dunn, R. (1984). Learning style: state of science. *Theory into Practice*, 23, 10-19.

Dunn, R. Gianitti M. C., Murray, J. B., Rossi, I. ve Quinn, G. P. (1990). Grouping Students for Instruction: Effecets of Learning Style on Achievent and Attitudes. *The Journal of Social Psychology*, 130 (4), 485-494.

Fatt, J. P. T. (2000). Understanding the Learning Styles of Students: Implications for Educators. *International Journal of Sociology and Social Policy,* 20, 31-45.

Felder, R. M., & Silverman L. K. (1988). Learning and teaching styles in engineering education. *Engineering Education*, 78, 674-681.

Gökdağ, M. (2004). *Sosyal Bilgiler Öğretiminde İşbirlikli Öğrenme , Öğrenme Stilleri , Akademik Başarı ve Cinsiyet İlişkileri*. (Unpublished doctoral dissertation). Dokuz Eylül University, İzmir.

Hall, E. & Moseley, D. (2005). Is there a role for learning styles in personalized education and training. *International Journal of Lifelong Education,* 24(3) 243-255.

Heffler, B. (2001). Individual learning style and the learning style inventory. *Educational Studies*, 27, 307-316.

Hench, T. L. (1993). Combining CAL, learning styles and cooperative learning for more effective physics instruction. *European Journal of Engineering Education*, 18(3), 255-260

Johnson, D. W. & Johnson, R. T. (1999). Making cooperative learning work. *Theory into Practice*, 38, 67-75.

Johnson, D. W. & Johnson, R. T. (2000). How can we put cooperative learning into practice? *The Science Teacher*, 67, 39.

Johnson, D. W., Johnson, R. T., & Holubec, E .J. (1994). *The nuts & bolts of cooperative learning*. Edina, MN: Interaction Book Company.

Johnson, D. W., Johnson, R. T., & Holubec, E. J. (1998). *Cooperation in the classroom*. Edina, MN: Interaction Book Company.

Lincoln, F., & Rademacher, B. (2006). Learning styles of ESL students in community colleges. *Community College Journal of Research and Practice*, 30, 485–500.

Marr, M. B. (1997). Cooperative learning: a brief review. *Reading & Writing Quarterly*, 13, 7-20.

Miller, P. (2001). Learning styles: The multi media of the mind. Retrieved from ERIC database. (ED451140).

Reichadt, C.S. (2009). Quasi-experimental design. In R. Millsap & A. Maydeu-Olivares (Eds.), Sage handbook of quantitative methods in psychology (pp. 46–71). Thousand Oaks, CA: Sage.

Slavin, R. E. (1978). Student teams and achievement division. *Journal of Research and Development in Education*, 12, 39-49.

Slavin R. E. (1996). *Education for all*. Lisse: Swets & Zeitlinger.

Tatar, E., Tüysüz, C., & İlhan, N. (2008). Kimya öğretmen adaylarının öğrenme stillerinin akademik başarıları ile ilişkisi. Mustafa Kemal Üniversitesi Sosyal Bilimler Enstitüsü Dergisi. 5, 10, 185-192.

Wills, M., & Hodson, V. K. (1999). Discover your child's learning style, Rocklin, CA: Prima Publishing.