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The Effect of Using Mnemonic Strategies in Science Education on Students' Academic Achievement and Retention

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Abstract

The aim of this study is to investigate the effect of using mnemonic strategies in science education on students' academic achievement and retention. In the study where a quasi-experimental research model was used, the 6th grade science unit was taught to the experimental group using mnemonic strategies and to the control group using the normal curriculum without any intervention. The science achievement test developed as a data collection tool was implemented as a pre-test, post-test, and retention test. According to the analysis, it was determined that there was a statistically significant difference between the groups in terms of both academic achievement and retention in favor of the experimental group to which mnemonic strategies were implemented. It was concluded that the impact of using mnemonic strategies in science education on academic achievement and retention was higher than the method used within the normal curriculum.

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Introduction

Science, which has been developing rapidly in the world, has integrated with technology in recent years, and as a result, is changing the qualities, competencies, and ways of learning knowledge of individuals (Kaya et al., 2025). Individuals are active learners during this process and continually apply the knowledge they have acquired. In order to keep up with the change and to raise individuals with the desired qualifications, countries in competition have started to adapt individuals to the new system by organizing their curriculum (Öznalbant, 2007). For this reason, instead of a cursory model that takes knowledge from educators without fully comprehending it, it has become inevitable to move to an individual model that can access new knowledge using knowledge, select and extract the desired knowledge from the mixed knowledge spiral, and solve the problems that it

encounters in the process (Korkmaz & Kaptan, 2002). In particular, the rapid development of science in the world and the desire of countries to be at the forefront of the science and technology race have increased the interest in science education in schools and caused more efforts to be made to train qualified individuals (Ayas, 1995). In this sense, while educational approaches and techniques applied in schools are of critical importance for countries, innovative and different teaching methods are also needed to raise qualified individuals (Kovacs, 2017).

One of the biggest problems of the educational programs implemented by educational institutions that undertake important tasks in raising qualified individuals of the future is that they lead students to memorization (Yılmaz & Altınkurt, 2011). Turan (2006) states that the probability of a rote-based teaching approach resulting in real learning is quite low. When a rote-based and teacher-focused curriculum is applied to students, many different problems arise, such as the inability to learn knowledge, the inability to transfer it to daily life, and the inability to reveal students' talents and abilities (Yeşil & Şahan, 2015). Taşdelen (2012) states that education based on rote learning makes students passive, turning them into individuals who are far from questioning, criticizing, and creativity. From a scientific point of view, taking knowledge with a rote approach constantly develops the left hemisphere of the brain in individuals, while the right hemisphere fails to develop (Buzan, 1999). In other words, as the dominance of using one half of the brain increases, it becomes more difficult to use the other half (Erduran-Avcı, 2008). At this point, an education system that constantly activates the left hemisphere, especially in schools, can lead students to memorize, resulting in a mindset based solely on logic and calculations, far from creativity and problem-solving skills. To prevent this situation, diversity, originality, innovation, flexibility, and imagination should be included in the learning process, and creative thinking should be encouraged by utilizing characteristics such as rationality, causality, and analysis-synthesis in the logical thinking process (Yıldırım, 2004). In this context, in science education, which is one of the positive sciences, it is very important for individuals to gain scientific and creative thinking competence, especially in the logical thinking process, for the realization of in-depth and permanent learning (Hacıoğlu & Kutru, 2021). According to the results of many studies on brain hemispheres that support this idea, it is stated that real learning in individuals can be realized by using both hemispheres of the brain together and in a balanced way (Nakiboğlu, 2003). In some neuroscientific studies, it is stated that both

hemispheres of the brain should be used together in order for individuals to learn quickly and permanently and that the materials provided to individuals in this way can facilitate efficient learning (Uluorta & Atabek, 2003).

While the left hemisphere of the human brain processes knowledge, the right hemisphere deduces meanings from events by establishing contexts (Ornstein, 2004). Especially in science education, the balanced occurrence of these two events in individuals, that is, the effective use of the right hemisphere by including it in the process along with the left hemisphere, can be beneficial in achieving efficient and permanent learning. At this point, the inclusion of mnemonic strategies in the learning process, which are generally based on imagination, visualization and obtaining imaginary images in the mind, may have a positive effect on raising more academically successful individuals.

The realization of efficient and permanent learning in students directly affects their success both in school lessons and in the exams that will shape their careers. Among the reasons why students do not achieve the success scores they want from these exams may be the lack of real learning in students, insufficient retention of learned knowledge, and difficulties in recalling knowledge. In order to avoid problems, especially in the process of accessing knowledge, this knowledge must first be correctly coded into long-term memory (Güven, 2004). At this point, memory techniques strategies help individuals to correctly encode new knowledge by associating it with the old knowledge in long-term memory (Kaya & Çevik, 2020). In recent years, studies on the curriculum implemented in schools have shown that there are problems such as the lack of permanence in the knowledge taught to students, memorization of the knowledge by the students during only the exam times, forgetting it shortly after the exam, and not being able to use this knowledge effectively in real social life (Şimşek, 2000). Especially when the curriculums of developed countries are analyzed, it is observed that some studies have been carried out on different teaching models that take into account student differences, teach information more easily and provide retention (Demir & Gürol, 2015). The main purpose of these studies is to make the lessons as easy as possible for the students to ensure real learning and retention of the learned knowledge. Science courses, on the other hand, may be complex and difficult to understand for students due to the fact that they consist of both theoretical and practical parts and include many imaginary concepts. For example, students may have difficulty in understanding some concepts in science courses or they may confuse concepts and fall into

misconceptions. They may not be able to remember specific theorems or formulas and may confuse the order of events that are expected to occur. In addition, students' encountering difficulties in science courses may negatively affect their motivation and cause them to behave reluctantly in out-of-school studies. In order to prevent this situation that will negatively affect academic achievement, eliminating the factors that cause difficulties in the science course with alternative strategies can be beneficial in making the course more enjoyable for students and realizing efficient learning. In this context, the use of mnemonic strategies, especially when learners have difficulties, can facilitate learning and prevent loss of motivation.

When the literature is reviewed, it is realized that there are various classifications about mnemonics (Kormaz & Mahiroğlu, 2007). In this study, loci, snapshot and linking techniques from visual techniques, acrostic and acronym techniques from phonetic techniques were used. The loci technique consists of two basic elements. Selecting the place and creating the image. Each remembered object is associated with the relevant places, and the mental image is formed (Yeniçeri-Tuna & Topçuoğlu-Ünal, 2023). Although the linking technique is used when the knowledge to be learned needs to be remembered in a certain order, both the right and left hemispheres are active since the associations of the knowledge are memorized in a certain sequence. In this way, a dynamic synthesis occurs in the brain (Saygın et al., 2000). Although the acronym technique is based on the principle of deriving a new word by combining the first letters of the words to be remembered, the aim of this technique is to make an association between each letter of the newly derived word and the first letter of the word to be remembered (Aydın, 2021). The acrostic technique is generally based on the principle of combining multiple words together to form a sentence that is meaningful or meaningless, rhymes, and facilitates association (Kayacan et al., 2019). The snapshot technique is based on the principle of creating mental images of the knowledge to be remembered, and photographs taken instantly in the mind are linked to this knowledge (Deckard, 2020).

The contemporary understanding of education imposes great responsibilities on educators regarding the selection and application of appropriate teaching methods and techniques in order to make learning effective, efficient and permanent (Bayrakçeken et al., 2015). In this context, especially in science courses, the use of mnemonic strategies in the process of sending the knowledge to the long-term memory by associating the knowledge in

the working memory with the pre-existing knowledge, known as the coding method, may have positive effects on the increase of students' achievement by providing convenience to students in the realization of real and permanent learning.

In this study loci, snapshot, linking, acrostic and acronym techniques were used in the course material designed for the 6th grade unit of the science course. It is thought that this uniquely prepared course material and the implementation stages that overlap with the constructivist approach will serve as an example for candidate educators, educators, school administrators and researchers and will contribute to the field.

Aim of the Research and Sub-Problems

This study aimed to investigate the effects of using mnemonic strategies in science education on students' academic achievement and retention**.** For this purpose, it was investigated how the teaching with mnemonic strategies in the experimental group during the 6th grade science unit had an impact on the academic achievement and retention of the students compared to the teaching within the normal curriculum without any intervention in the control group. In this direction, answers to the following sub-problems were sought.

1. Are the pre-test mean achievement scores of the groups significantly different?
2. Are the post-test mean achievement scores of the groups significantly different?
3. Are the retention test mean achievement scores of the groups significantly different?

Method

Research Design

In this study, quasi-experimental design, one of the quantitative research approaches, was used. Although the quasi-experimental research design is a research model that is frequently used, especially in educational research, in this model, researchers determine the experimental and control groups by making random selections among the classes previously formed by the school administrations (Çepni, 2018).

Research Participants

The research participants consisted of 56 students studying in the 6th grade of a public middle school in Ordu province in the 2021–2022 academic year. The students were between 11 and 12 years old. Two classes were randomly selected from among all 6th graders studying at the school, and both classes were taught by the same science teacher to ensure instructional consistency. Participation was based solely on students' enrollment in

the selected classes, and no additional inclusion or exclusion criteria were applied. The SAT was administered to these classes as a pre-test. Since there was no statistically significant difference between the pre-test mean achievement scores of the classes, one was randomly assigned as the experimental group and the other as the control group. The gender and frequency distributions of the participants are shown in Table 2.

Table 2. Distribution of the participants by gender

Group	Experimental Group		Control Group	
Gender	f	%	f	%
Female	16	57,14	13	46,42
Male	12	42,86	15	53,58
Total	28	100	28	100

Data Collection Tool

The SAT was used as a data collection tool in the study. A question set consisting of 100 questions compatible with the acquisitions of the unit within the curriculum was prepared. All questions were meticulously examined by 3 academicians and 2 science educators who are experts in their fields, and the number of questions was first dropped to 50 and then to 25. In the test where the questions were multiple-choice, the evaluation was made over a total of 25 points. Students scored 1 point for each correct answer and 0 points for each wrong answer or a question left blank. The pilot study of SAT was carried out with 250 students studying in the 7th grade of middle schools in Ordu province. The data obtained were entered into the Test Analysis Programme (TAP). Finally, the reliability and validity of the SAT were checked.

According to TAP, mean, median and mode values are very close to each other and skewness and kurtosis values are between +1,5 and -1,5, which shows that the data have a normal distribution. The Kuder-Richardson (KR-20) reliability coefficient calculated as 0,86 (very close to 1) shows that the test is reliable (Can, 2019). In addition, average item difficulty and mean discrimination index values of the test were also analyzed to ensure the validity of the SAT. The average item difficulty value of a test less than 0,30 indicates that the test is very difficult, between 0,30 and 0,49 indicates that the test is difficult, between 0,50 and 0,69 indicates that the test is moderately difficult, and greater than 0,69 indicates that the test is easy (Boopathiraj & Chellamani, 2013). The average item difficulty of the SAT was calculated as 0,60, indicating that the test was of moderate difficulty. The average discrimination index of a test is interpreted as excellent for values of 0,40 and above, very good for values between

0,30 and 0,39, should be improved or corrected for values between 0,20 and 0,29, and very poor for values of 0,19 and below (Hasançebi et al., 2020). The average discrimination index of the SAT was calculated as 0,56 and it can be stated that the discrimination index of the test is excellent. In addition, since none of the discrimination indices of the items in the SAT were below 0,30, there was no need to remove or correct any item.

Data Analysis

The data obtained from the study were analyzed with the Statistical Package for Social Sciences (SPSS) program. First of all, it was checked whether the data obtained from the related sub-problems showed normal distribution or not. In the analyses, it was seen that the central tendency measures (mean, median, mode) of the data related to the sub-problems were close to each other, the kurtosis and skewness values were between -1,5 and +1,5 and the Shapiro-Wilk normality test showed that the condition was provided (p>0,05). According to the Levene test result, it was seen that the variances of the data showed a homogeneous distribution (p>0,05). As a result, it was determined that the data in the related sub-problems were normally distributed and suitable for the use of parametric tests. For this reason, it was decided to use an independent sample t-test in the comparisons of variables between groups.

Material Designed with Mnemonic Strategies

The material applied to the experimental group was developed by the researcher in accordance with the acquisitions in the 6th grade "Solar System and Eclipses" unit. The literature review phase for the material took two months, while the design phase took approximately three months. During the design phase, a sample lesson material was prepared, and the opinions of academics and science educators who are experts in this field were sought. After the material was finalized in line with the experts' recommendations, their opinions were sought again, and it was prepared for implementation within the scope of the study.

In the material, acrostic, acronym, snapshot, linking, and loci techniques were used in accordance with the acquisitions. The subtopics, acquisitions, and explanations of the unit to be taught with mnemonic strategies are shown in Table 3.

Table 3. Planning the experimental implementation

Subtopics	Acquisitions	Explanations
Solar System	The planets in the solar system are compared with each other.	1. The solar system is explained by the snapshot and loci techniques. 2. The sequence of the planets' distances from the sun is given with acrostic technique. 3. The distinction between inner and outer planets is explained with snapshot, acronym, acrostic techniques. 4. Knowledge about the sun and planet is given with acronym, linking, snapshot techniques. 5. The sequence of the planets in the solar system from largest to smallest is given with acrostic technique. 6. The concepts of asteroid and meteorite are explained with linking, snapshot and acrostic techniques.
Solar and Lunar Eclipses	It is predicted how a solar eclipse occurs.	7. The solar eclipse is explained with the linking and the snapshot techniques.
Solar and Lunar Eclipses	It is predicted how a lunar eclipse occurs.	8. The lunar eclipse is explained with the linking and the snapshot techniques.

Stages of Experimental Implementation

At the outset of the study, two classes were randomly selected from the 6th grade at a public middle school. The Science Achievement Test (SAT) was administered as a pre-test to assess initial achievement levels. Since no statistically significant difference was found between the pre-test mean scores of the classes, one class was randomly assigned as the experimental group and the other as the control group. The science teacher of both groups was briefed on the study procedures to ensure consistency in instruction. The teaching phase spanned 14 class hours over a period of 4 weeks. Lessons for the experimental group were delivered using course materials specifically designed with mnemonic strategies and structured activities intended to enhance students' comprehension and memory of science concepts. These activities included concept mapping, visual aids, interactive exercises, and mnemonic cues integrated into lesson content. The control group received instruction according to the standard curriculum, without additional interventions or mnemonic strategies, covering the same science topics to maintain comparability. Following the teaching phase, the SAT was administered as a post-test to both groups. To evaluate knowledge retention, the SAT was administered again 10 weeks after the post-test. The

collected data were analyzed using appropriate statistical techniques to examine the effects of mnemonic-based instruction on students' achievement and retention of science concepts, allowing for a detailed comparison between the experimental and control groups.

Examples of Implementations in the Material

In the study, some of the implementations included in the material are shown with the explanations in Table 4.

Table 4. Sample implementations and explanations

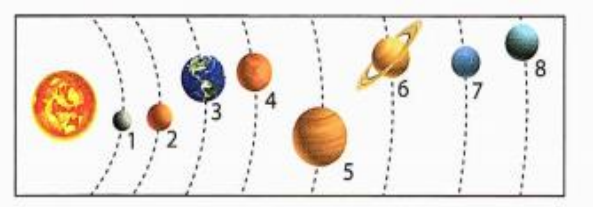
Concept	Purpose	Explanations
Solar System	Teaching the concept of solar system with snapshot and loci techniques.	The students are asked to close their eyes and imagine a carousel in an amusement park they visited in their childhood. They are told that the carousel is a little different from normal carousels. They are asked to imagine that there is a huge sun in the center, 8 planets around the sun at different distances from it, satellites around some of the planets, and meteors, comets and asteroids in between. Then, they are asked to visualize in their minds that the planets around the sun start to revolve around themselves and also revolve around the sun when the carousel starts to rotate. Finally, it is stated that the community formed by this carousel is called the solar system.
Solar Eclipses	Teaching the solar eclipse event with linking and snapshot techniques.	The students are asked to close their eyes and imagine that they are sunbathing on the beach on a hot, sunny summer day. Then, they are asked to imagine that suddenly it starts to darken slowly and when they look at the sky, the moon slowly comes in front of the sun and covers it. Afterwards they are asked to imagine that the moon slowly starts to move away from the sun and the sky slowly brightens again. Finally, students are told that sometimes the moon gets between the sun and the earth and takes great pleasure in making a joke. Finally, it is stated that this event is called the solar eclipse.
Lunar Eclipses	Teaching the lunar eclipse event with linking and snapshot techniques.	The students are asked to close their eyes and imagine that they are lying on the grass on a hot summer night and watching the big and bright moon in the sky. Then, they are asked to imagine that suddenly, slowly, the moon starts to darken and the brightness that hits their faces is replaced by darkness. Then they are asked to visualize that the brightness of the moon slowly starts to come back. Finally, students are told that the earth is in front of the sun and intervenes between the sun and the moon, taking revenge for the moon's joke on the beach by leaving it in darkness, and this event is called the lunar eclipse.

Proximity Ranking of the Planets	Teaching the order of the planets according to their proximity to the sun with the acrostic technique.	The order of the planets from closest to farthest from the Sun is shown on the screen. The order is shown by writing the acrostic "**M**eraklı **V**eli **D**ünya'dan **M**ars'a **J**eton **S**atmaya **U**çtu, **N**eden?" consisting of the first letters of the planets **M**ercury, **V**enus, **E**arth, **M**ars, **J**upiter, **S**aturn, **U**ranus, and **N**eptune.
Size Ranking of the Planets	Teaching the order of the planets from big to small with acrostic technique.	The order of the planets from largest to smallest is shown on the screen. The order is shown by writing the acrostic "**J**etonları **S**atan **U**ras **N**eden **D**ünya'daki **V**eli'yi **M**ahvedip **M**eraklandırdı?" consisting of the first letters of the planets **J**üpiter, **S**atürn, **U**ranüs, **N**eptün, **D**ünya, **V**enüs, **M**ars, **M**erkür.

Examples of Questions in the SAT

In the study, some of the questions included in the SAT and applied to the groups are shown in Table 4.

Table 4. Examples of questions in the SAT

Concept	Questions
Solar System	Which of the following characteristics is not common to all planets? A) Orbiting around the Sun. B) Rotating around its own axis. C) Having a specific orbit. D) Having a satellite.
Solar and Lunar Eclipses	Which of the following statements is correct? A) During a lunar eclipse, the sun comes between the earth and the moon. B) During a solar eclipse, the earth passes between the moon and the sun. C) During a lunar eclipse, the moon comes between the earth and the sun. D) In a solar eclipse, the moon comes between the sun and the earth.
Proximity Ranking of the Planets	 The planets in the solar system are numbered as shown in the figure. Accordingly, Uranus is located between the planets indicated by which numbers? A) 6 and 8 B) 5 and 7 C) 4 and 6 D) 3 and 4

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Solar and Lunar Eclipses Size Ranking of the Planets Proximity Ranking of the Planets	Which of the following is incorrect? A) A lunar eclipse occurs when the earth moves between the sun and the moon. B) During a aolar eclipse, the moon comes between the earth and the sun. C) The largest planet of the solar system ranks 5th in terms of proximity to the sun. D) The most distant planet in the solar system is bigger than Saturn in size.

Findings

The following section presents the analysis results of the study, including pre-test, post-test, and retention test scores, in order to examine the effects of mnemonic-based instruction on students' science achievement, as well as to evaluate the immediate and long-term impact of the intervention on their learning outcomes.

The first sub-problem was, "Are the pre-test mean achievement scores of the groups significantly different?" The analysis of this sub-problem was made by using an independent sample t-test, and the results are shown in Table 5.

Table 5. Pre-test independent sample t-test analysis results

Test	Groups	N	$\overline{X}$	SS	Sd	t	p
Pre-Test	Experimental	28	7,89	± 1,28	54	0,938	0,353
	Control	28	7,54	± 1,55			

Based on the results of the independent sample t-test analysis of the pre-test applied to measure the academic achievement of the groups before the teaching phase, there was no statistically significant difference between the mean achievement scores of the experimental group (X_e=7,89) and the control group (X_c=7,54), ($t_{(54)}$=0,938, p=0,353), (p>0,05).

The second sub-problem was, "Are the post-test mean achievement scores of the groups significantly different?" The analysis of this sub-problem was made by using an independent sample t-test, and the results are shown in Table 6.

Table 6. Post-test independent sample t-test analysis results

Test	Groups	N	$\overline{X}$	SS	Sd	t	p	η^2
Post-Test	Experimental	28	17,96	± 2,71	54	5,96	0,000	0,39
	Control	28	13,46	± 2,92				

Based on the results of the independent sample t-test analysis of the post-test applied to the groups immediately after the completion of the teaching phases, a statistically significant difference was found between the mean achievement scores of the experimental group (X_e=17,96) and the control group (X_c=13,46) in favor of the experimental group ($t_{(54)}$=5,96, p=0,00), (p<0,05). The effect size value of this significant difference was calculated as (η^2=0,39). The third sub-problem was, "Are the retention test mean achievement scores of the groups significantly different?" The analysis of this sub-problem was made by using an independent sample t-test, and the results are shown in Table 7.

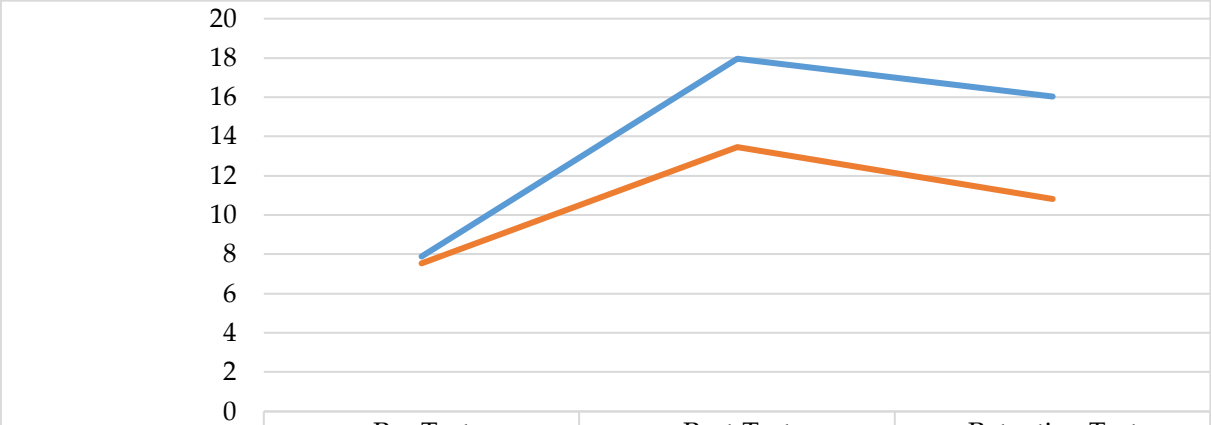
Table 7. Retention test independent sample t-test analysis results

Test	Groups	N	$\overline{X}$	SS	Sd	t	p	η^2
Retention	Experimental	28	16,04	± 2,78	54	8,37	0,000	0,56
	Control	28	10,82	± 1,76				

Based on the results of the independent sample t-test analysis of the retention test applied to the groups 10 weeks after the post-test, a statistically significant difference was found between the mean achievement scores of the experimental group ($\overline{X}_e$=16,04) and the control group ($\overline{X}_c$=10,82) in favor of the experimental group ($t_{(54)}$=8,37, p=0,00), (p<0,05). The effect size value of this significant difference was calculated as (η^2=0,56).

Comparison of mean scores in tests

The mean score changes of the groups in all tests during the research process are shown in Figure 1.



	Pre-Test	Post-Test	Retention Test
Experimental	7.89	17.96	16.04
Control	7.54	13.46	10.82

Figure 1. The mean score changes of the groups in the tests

Discussion and Conclusion

In the first sub-problem, it was analyzed whether there was a significant difference between the pre-test mean achievement scores of the groups. The purpose of the pre-test applied before the teaching phase was to examine the academic achievement levels and equivalence of the groups in the "Solar System and Eclipses" unit. Based on the results of the independent sample t-test analysis of the pretest, there is no significant difference between the mean achievement scores of the experimental group ($\bar{X}_e$=7,89) and the control group ($\bar{X}_c$=7,54). The fact that there was no significant difference may be evaluated as meaning that the groups were equivalent in terms of knowledge about the unit before the teaching phases. This result is a very positive and desired situation in terms of the healthy functioning of the research and the observation of the effect that will occur in the manipulated experimental group (Büyüköztürk, 2020). Similar to this result, Küçük (2023) investigated the effect of a learning environment in which activities prepared based on mnemonic strategies were used within the scope of the 7th grade "Culture and Heritage" unit on students' academic achievement, attitudes towards social studies courses and retention of learning. Comparing the academic achievement pre-test scores of the groups, it was calculated that the mean rank of the experimental group was ($\bar{X}_e$=18.84) and the control group was ($\bar{X}_c$=14.16), with a significance value greater than ,05 according to the Mann-Whitney U test results. It was concluded that the experimental and control groups were equivalent to each other in terms of academic achievement scores before the teaching phase and that there was no difference

between the groups that would threaten internal validity. In another study, Pürbudak and Usta (2019) applied a digital story prepared using the keyword method, one of the memory-supportive strategies, according to the ASSURE instructional design model, and examined its effect on 5th-grade middle school students' attitudes toward the foreign language course. When the pre-test attitude scores of the experimental and control groups were examined, no statistically significant difference was found between the experimental group ($\bar{X}$= 40.48) and the control group ($\bar{X}$ = 39.96). This finding indicates that the groups were equivalent at the pre-test stage and that the study was conducted in a methodologically sound manner.

In the second sub-problem, it was investigated whether there was a significant difference between the post-test mean achievement scores of the groups. Based on the results of the independent sample t-test analysis of the post-test applied after the teaching phase, it was seen that there was a statistically significant difference between the mean achievement scores of the experimental group ($\bar{X}_e$=17.96) and the control group ($\bar{X}_c$=13.46) in favor of the experimental group in which mnemonic strategies were implemented, and the effect size value of this significant difference was calculated as (η^2=0.39). Although the effect size value varies between 0 and 1 effect size values at the level of .01, .06, .14 are evaluated as small, medium and large effect sizes, respectively (Büyüköztürk, 2020). The calculated effect size value shows that the mnemonic strategies used in the experimental group had a higher impact on academic achievement than the control group. It can be concluded that the effect of using mnemonic strategies in science education on students' academic achievement is higher than the method implemented within the normal curriculum. A review of the literature shows that there are studies with similar results. Kaya and Çevik (2020) investigated the effect of teaching the 6th grade science course unit with mnemonic strategies on academic achievement and retention. When the academic achievement post-test scores of the groups were compared, according to the independent samples t-test results, it was seen that there was a statistical difference between the experimental group ($\bar{X}_e$=17,86) and the control group ($\bar{X}_c$=15,87) in favor of the experimental group in which mnemonic strategies were implemented. It was concluded that mnemonic strategies positively affected students' academic achievement. Yıldız (2013) investigated the effect of teaching the 7th grade science and technology course unit with mnemonic strategies on academic achievement and concept learning. The unit was taught using techniques such as explanation and question-answer based on constructivism in both groups, and the students in the experimental group were

supported with mnemonic strategies. According to the analysis, the post-test corrected mean scores were ($\bar{X}_e$=17.77) for the experimental group and ($\bar{X}_c$=14.89) for the control group. In the ANCOVA results regarding whether the difference between the post-test mean scores of the groups was significant or not, it was detected that there was a significant difference between the corrected post-test achievement score means of the groups in favor of the experimental group in which mnemonic strategies were implemented. Thus, it was concluded that teaching the unit with mnemonic strategies positively affected science achievement. Al-Khawaldeh and Al-Khasawneh (2019) investigated the effects of the mnemonic keyword strategy on vocabulary learning and retention among 40 ninth-grade students with learning disabilities at a middle school in Abha, Asir region, Saudi Arabia. The analysis revealed that the experimental group, which received the inquiry-based learning model supported with the mnemonic strategy, had a significantly higher post-test mean achievement score ($\bar{X}$ = 90.65) compared to the control group, which did not use mnemonic strategies ($\bar{X}$ = 80.65).

In the third sub-problem, it was investigated whether there was a significant difference between the retention test mean achievement scores of the groups. Based on the results of the independent sample t-test analysis of the retention test applied 10 weeks after the completion of the post-test phase for both groups, it was seen that there was a statistically significant difference between the mean achievement scores of the experimental group ($\bar{X}_e$=16.04) and the control group ($\bar{X}_c$=10.82) in favor of the experimental group, and the effect size value of this significant difference was calculated as (η^2=0.56). The calculated effect size value shows that the mnemonic strategies used in the experimental group had a higher impact on retention than the control group. Thus, it can be concluded that the effect of using mnemonic strategies in science education on the retention of learned information is higher than the method applied within the normal curriculum. In the retention test applied 10 weeks after the post-test implementation, it can be considered normal that the mean achievement scores decreased due to the fact that a certain amount of forgetting occurred in both groups. However, it is seen that the decrease in the experimental group using mnemonic strategies is less than the decrease in the control group where the method within the normal curriculum is applied. A review of the literature shows that there are studies with similar results. Köksal (2013) investigated the effect of memory-supportive strategies used in primary school 5th grade English lessons on achievement, attitude, vocabulary knowledge,

and retention. In the study conducted with 56 students, the keyword method, one of the memory-supportive strategies, was used to teach vocabulary to the experimental group, while teaching methods related to the current primary education program were used for the control group. When the retention test scores of the groups were compared, it was seen that there was a statistical difference between the retention test score of the experimental group ($\bar{X}_e$=30,93) and the control group ($\bar{X}_c$=22,04) in favor of the experimental group in which mnemonic strategies were applied. Thus, it was concluded that the activities using the keyword method in the experimental group were more effective in ensuring the retention of the English vocabulary learned than the activities implemented in the control group within the normal program. Uça and Öksüz (2016) investigated the effect of mnemonic prompting on both academic achievement and retention of students on the order of operations in 6th grade mathematics teaching. In the study conducted with 156 students, mnemonic prompts were used in the experimental group, while only the order of operations rule was used in the control group. When the retention test scores of the groups were compared, it was seen that there was a statistical difference between the retention test score of the experimental group ($\bar{X}_e$=17,18) and the control group ($\bar{X}_c$=12,17) in favor of the experimental group in which mnemonic strategies were applied. Thus, it was concluded that the mnemonic prompting kept the retention levels of the experimental group students considerably higher than the students in the control group. They also stated that the mnemonic prompting positively affected the academic achievement, and the students were able to transfer the order of operations to the learning of new concepts by associating old and new knowledge with these strategies.

When the results obtained as a result of the analyses related to all sub-problems in the research are evaluated, it can be said that the use of memory techniques strategies in science education has a positive effect on both academic achievement and retention. Mnemonic strategies can be especially useful in teaching concepts that are difficult to learn or remember to students in a way to help the teaching methods and techniques recommended in the current curriculum and to be used when necessary. In this respect, it is thought that educators and students having knowledge about mnemonic strategies and applying these techniques correctly will provide great convenience in both teaching and learning. In line with all these views, the following recommendations have been developed for researchers, prospective educators, teachers, and students who want to be interested in this field.

1. Researchers can examine the effects of memory technique strategies in subjects and fields other than science education. Since this study was limited to the 6th grade science course and the "Solar System and Eclipses" unit, conducting research in subjects such as mathematics, social studies, or foreign languages can increase the generalizability of the strategies and allow for a comparison of their effectiveness across different fields.
2. Researchers can publish resource books, instructional materials, or digital content incorporating memory technique strategies in line with their studies. As only in-class materials were used in the current study, such publications can enhance access for teachers and students and support the applicability and sustainability of the strategies.
3. University teacher candidates having knowledge of and practice with memory technique strategies can more effectively implement these techniques in their professional lives. Since teacher candidates were not included in this study, future research can examine how these strategies can be integrated with teacher education and pedagogical competencies.
4. Memory technique training programs or workshops organized by field experts can help teachers learn these strategies and develop the skills to implement them effectively in the classroom. As this study was limited to the implementation by a single teacher, conducting studies with different teachers can better demonstrate the diversity and classroom effectiveness of the strategies.
5. Teachers can use memory technique strategies when students have difficulties understanding content or concepts. Since this study applied the strategies to only a single unit, future research on other topics or more complex concepts can reveal how teachers adapt these strategies to different content areas.
6. Students having knowledge of and actively applying memory technique strategies can facilitate easier learning and retention of information both in classroom lessons and in out-of-school studies. As the intervention in this study was limited to 14 class hours, longer-term or regular applications could be examined to assess the long-term effects of the strategies.
7. Students can also use memory technique strategies during out-of-school studies, especially when preparing for exams or reviewing topics, to learn information more

effectively and increase motivation. Since this study only evaluated in-class applications, future research can investigate the effects of these strategies in individual review sessions or different learning environments.

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Caner ÇABUK: *Conceptualization, literature review, data curation, methodology, implementation, data analysis, original draft, language editing, organization, and writing.*

Cengiz ÖZYÜREK: *Control, review and regulation.*

References

Al-Khawaldeh, M. A & Al-Khasawneh, F. M. (2019). The effect of mnemonic keyword strategy instruction on vocabulary retention of students with learning disabilities. *International Journal of English Linguistics*, 9, 138-138.

Ayas, A. (1995). Fen bilimlerinde program geliştirme ve uygulama teknikleri üzerine bir çalışma iki çağdaş yaklaşımın değerlendirilmesi [A study on program development and implementation techniques in science and evaluation of two contemporary approaches]. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi, 11(11),* 149-155.

Aydın, Y. (2021*). Fonetik sistem: Hafıza teknikleri odaklanma dikkat geliştirme [Phonetic system: Memory techniques focus attention development]*. Az Kitap Publishing.

Bayrakçeken, S., Doymuş, K., & Doğan, A. (2015). *İşbirlikli öğrenme modeli ve uygulanması [The cooperative learning model and its implementation].* Pegem Akademi Publishing.

Boopathiraj, C., & Chellamani, K. (2013). Analysis of test items on difficulty level and discrimination index in the test for research in education. *International Journal of Social Science and Interdisciplinary Research*, *2(2),* 189-193.

Buzan, T. (1999). *Aklını en iyi şekilde kullan [Make the most of your mind].* Arion Publishing.

Büyüköztürk, Ş. (2020). *Sosyal bilimler için veri analizi el kitabı [Handbook of data analysis for social sciences].* Pegem Akademi Publishing.

Can, A. (2019). *SPSS ile bilimsel araştırma sürecinde nicel veri analizi [Quantitative data analysis in scientific research process with SPSS].* Pegem Akademi Publishing.

Çepni, S. (2018). *Araştırma ve proje çalışmalarına giriş [Introducing research and project studies].* Celepler Matbaacılık.

Deckard, A.W. (2020). *Güçlü hafıza teknikleri. [Powerful memory techniques].* Eftelya Publication.

Demir, S., & Gürol, M. (2015). Farklılaştırılmış öğretim yöntemlerinin derin ve yüzeysel öğrenen öğrencilerin kalıcılık puanları üzerindeki etkisi [The effect of differentiated learning on the retainment scores of deep and surface learners*]. Pegem Journal of Education and Instruction*, *5(2),* 187-206.

Erduran-Avcı, D. (2008). Beyin yarı kürelerinin baskın olarak kullanılmasına yönelik öğretim stratejileri [Teaching strategies for the dominant use of brain hemispheres]. *Gazi Üniversitesi Eğitim Fakültesi Dergisi*, *28(2),* 1-17.

Güven, M. (2004). *Öğrenme stilleri ile öğrenme stratejileri arasındaki ilişki [The relationship between learning styles and learning strategies].* (Doctoral dissertation). Retrieved from the Council of Higher Education National Thesis Center. (Thesis Number: 143975).

Hacıoğlu, Y. & Kutru, Ç. (2021). Fen eğitimiyle yaratıcı düşünme becerisinin geliştirilmesi: Türkiye'de yürütülen lisansüstü tezlerden yansımalar [Developing creative thinking skills through science education: Reflections from graduate theses conducted in Turkey]. *Anadolu Öğretmen Dergisi*, *5(1),* 77-96.

Hasançebi, B., Terzi, Y., & Küçük, Z. (2020). Madde güçlük indeksi ve madde ayırt edicilik indeksine dayalı çeldirici analizi [Distractor analysis based on item difficulty index and item discrimination index]. *Gümüşhane Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, *10*(1), 224-240.

Kaya, D., Yaşar, A. Ö., Çetin, İ., & Kutluca, T. (2025). The relationship between the 21st-century skills and computational thinking skills of prospective mathematics and science teachers. *Journal of Pedagogical Research,* *9*(1), 73-95. https://doi.org/10.33902/JPR.202531498

Kaya, H., & Çevik, A. (2020). Fen bilimleri dersinde kullanılan bellek destekleyici stratejilerin akademik başarı ve kalıcılığa etkisi [Effect of memory supporting strategies used in science course on academic achievement and retention]. *Eğitim Kuram ve Uygulama Araştırmaları Dergisi*, *6(1),* 67-85.

Kayacan, K., Özlüleci, M., & Arslan, A. (2019). Fen bilimleri öğretmen adaylarının hafızalarında yer alan bellek destekleyiciler ve bunlara yönelik görüşlerinin incelenmesi [Investigation of the mnemonic in science teacher candidates' memories and opinions for them]. *International Journal of Humanities and Education*, *5(12),* 960-975.

Korkmaz, H., & Kaptan, F. (2002). Fen eğitiminde proje tabanlı öğrenmenin yaklaşımının ilköğretim öğrencilerinin akademik başarı, akademik benlik kavramı ve çalışma sürelerine etkisi [The effects of project-based learning on elementary school students'

academic achievement, academic self-concepts and study time in science education]. *Hacettepe Üniversitesi Eğitim Fakültesi Dergisi*, *22(22)*, 91-97.

Korkmaz, Ö., & Mahiroğlu, A. (2007). Beyin, bellek ve öğrenme [Brain, memory and learning]. *Kastamonu Education Journal*, *15(1)*, 93-104.

Kovacs, H. (2017). Learning and teaching in innovation: Why it is important for education in the 21st century. *Nevelestudomany*, *5(2)*, 45-60.

Köksal, O. (2013). *İlköğretim 5. sınıf İngilizce derslerinde kullanılan bellek destekleyici stratejilerin erişiye, tutuma, kelime bilgisine ve kalıcılığa etkisi [The effect of mnemonic devices on achievement, attitude, vocabulary learning and retention on the fifth-year primary school English lessons].* (Doctoral dissertation). Retrieved from the Council of Higher Education National Thesis Center. (Thesis Number: 321216).

Küçük, E. (2023). *Sosyal bilgiler dersinde bellek destekleyici stratejilerin akademik başarı ve kalıcılığa etkisi [The effect of memory supporting strategies on academic success and permanence in social studies lesson]*. (Master's dissertation). Retrieved from the Council of Higher Education National Thesis Center. (Thesis Number: 832577).

Nakiboğlu, M. (2003). Kuramdan uygulamaya beyin fırtınası yöntemi [Brainstorming method from theory to practice]. *Türk Eğitim Bilimleri Dergisi*, *1(3)*, 341-351.

Ornstein, R. (2004). *Sağduyu beyin yarımkürelerinin anlamı [Common sense brain hemispheres meaning]*. Kaknüs Publishing.

Öznalbant, E. (2007). *İlköğretim birinci kademe öğretim programlarının yeniden yapılandırılması konusunda vak'a çalışması [A case study on the reconstruction of the curriculum of the primary education].* (Master's dissertation). Retrieved from the Council of Higher Education National Thesis Center. (Thesis Number: 191602).

Pürbudak, A., & Usta, E. (2019). Bellek destekli strateji yöntemiyle hazırlanmış dijital öykünün yabancı dil dersi tutumuna etkisi [The effect of digital storytelling with memory supported strategy method on attitude towards foreign language course]. *Gazi Eğitim Bilimleri Dergisi*, *5(2)*, 95-114.

Saygın, O., Maraşlı, A., & Maraşlı, M. (2000*). Hafıza teknikleriyle beyin gücünü geliştirme [Developing brain power with memory techniques].* Hayat Publishing.

Şimşek, A. (2000). *Sınıfta demokrasi [Democracy in the classroom].* Eğitim Sen Publishing.

Taşdelen, V. (2012). Eğitimde ezberleme ve anlama [Memorization and comprehension in education]. *Bilim ve Aklın Aydınlığında Eğitim*, *143*, 12-17.

Turan, İ. (2006). Sınıf öğretmenliği programı öğrencilerinin coğrafi kavramları öğrenme düzeyleri ve ezbercilik [Geographical concepts learning levels and rote memorization of classroom teaching program students]. *Milli Eğitim Dergisi*, *170*, 274-292.

Uça, S., & Öksüz, C. (2016). Matematik öğretiminde işlem sırasının kavratılmasında yeni bir yaklaşım: mnemoni. [A new approach when comprehending the order of operations in mathematics instruction: mnemonics]. *Pamukkale Üniversitesi Eğitim Fakültesi Dergisi*, *39(39)*, 51-67.

Uluorta, N., & Atabek, E. (2003). Beyin eğitimi ve fen bilgisi laboratuvar öğretimindeki yeri [Brain education and its role in science laboratory teaching]. *Sakarya Üniversitesi Eğitim Fakültesi Dergisi*, *6*, 295-304.

Yeniçeri-Tuna, K., & Topçuoğlu-Ünal, F. (2023). Hafızada tutma tekniği ile ilgili konuşma etkinlikleri [Speaking activities related to memory retention technique]. *Dumlupınar Üniversitesi Eğitim Bilimleri Enstitüsü Dergisi*, *7*(2), 171-188.

Yeşil, R., & Şahan, E. (2015). Öğretmen adaylarının Türk eğitim sisteminin en önemli sorun, neden ve çözüm yollarına ilişkin algıları [Perceptions of teacher candidates about the most important problem of the Turkish education system, its reasons and its solutions] *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, *16*(3), 123-143.

Yıldız, K. (2013*). Fen ve teknoloji öğretiminde bellek destekleyici stratejilerin öğrencilerin başarılarına ve kavram öğrenmelerine etkisi, [The effect of memory-supporting strategies on success and concept learning in science and technology teaching].* (Master's dissertation). Retrieved from the Council of Higher Education National Thesis Center. (Thesis Number: 350017).

Yıldırım, R. (2004). *Öğrenmeyi öğrenmek* [*Learning to learn*]. Sistem Publishing.

Yılmaz, K., & Altınkurt, Y. (2011). Öğretmen adaylarının Türk eğitim sisteminin sorunlarına ilişkin görüşleri [Candidate teachers' views on the problems of the Turkish education system]. *Uluslararası İnsan Bilimleri Dergisi*, *8*(1), 942-973.