

# The Impact of Allosteric Learning on Students' Academic Achievement and Research Skills in the 5th Grade Social Studies Course

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**Abstract.** Allosteric learning approach advocates the acquisition of knowledge through experiences, and this could be appropriate for social studies course since its content is based on daily life. This study was conducted in a middle-school located in a province of Turkey during the fall-semester of the 2021-2022 academic year. The study investigated the impact of allosteric learning on 5<sup>th</sup> grade learners' academic achievement and research skills in social studies course. Moreover, the participating learners' views on the impact of allosteric learning on their academic achievement and research skills were also explored. The mixed embedded design was employed in the study. The participants consisted of 48 students, 23 in the experimental and 25 in the control group. To collect data, Science, Technology and Society Achievement Test, Research Skills Test, and interview form were employed. For analysis, t-test for independent samples, covariance analysis, and content analysis were used. It was found that the social studies course carried out within the scope of the allosteric learning approach increased students' academic achievement and improved their research skills. In addition, students believed that allosteric learning increased their academic achievement and equipped them with research skills.

**Keywords:** allosteric learning approach, academic achievement, research skills, social studies education, social studies teachers.

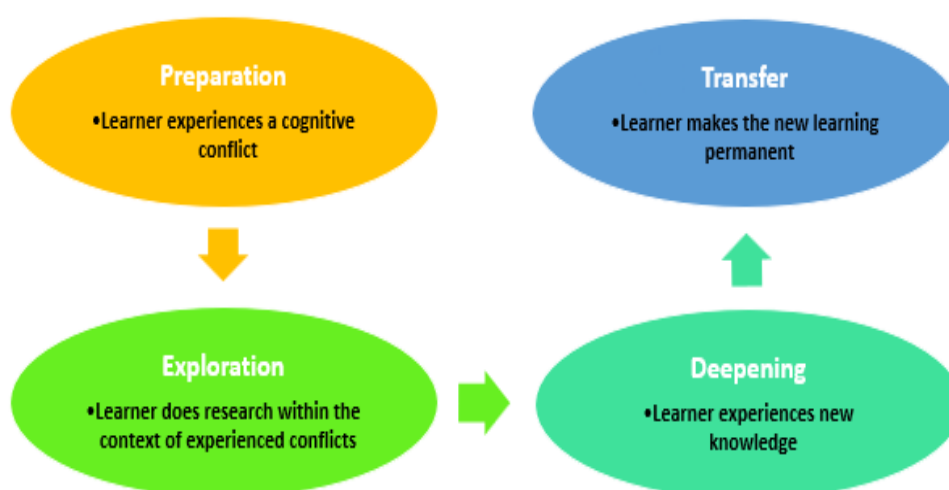
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**INTRODUCTION** ~ Learning takes place when individuals engage in various activities that would improve their knowledge, skills, and values. Appropriate pedagogical activities underlie the foundations of effective learning. As a matter of fact, practical and at the same time permanent learning is possible with approaches that can activate the mental dynamics of the learner, motivate the learner, and put the learner at the center of the learning process (Dewey, 2013). In this context, a wide variety of learning approaches have been developed to design effective learning processes, and one of these learning approaches is allosteric learning.

Allosteric learning, defined as beyond constructivism, was developed by Giordan (1995). Allosteric learning was first proposed as one of the approaches that can be used in science education (Potyrala, 2020). In fact, the approach takes its name from the terminology of biology, which is a branch of science (Budak, 2010). The concept of allosteric in biology means that enzymes regulate their activities according to external factors and adapt to changing

environmental conditions due to external factors. This behavior of enzymes inspired the process of designing variables of the allosteric learning process (Potyrala & Giordan, 2017).

The main variable in allosteric learning is the learner's self-cognitive designs. Self-cognitive designs consist of multifaceted structures in the mind of the learner. These designs can be affected by the conditions in the learning process and can be changed (Giordan et al., 1999). The allosteric learning approach focuses on processes of mental change. According to the allosteric learning approach, what changes in the learning process is not the learner's knowledge, but the cognitive networks that establish the relationship and produce meanings from this relationship (Giordan, 2010). In this learning process, the learner's cognitive structure based on research and questioning is reshaped (Pellaud & Eastes, 2003). The reason why the allosteric learning approach was defined as beyond constructivism and not within the scope of constructivism is that this approach, unlike constructivist learning models, predicts that learning processes and learner behaviors are shaped according to dynamic learning environments (Giordan, 1995). Furthermore, allosteric learning approach finds constructivism's principle of "constructing knowledge through new experiences within the scope of existing knowledge" insufficient, and advocates the recreation of knowledge (Pellaud et al, 2005). The learning process consists of four basic stages in the allosteric learning approach. These stages are shown in the Figure 1:



**Figure 1.** *The process of allosteric learning*

As presented in Figure 1, the allosteric learning approach predicts that learning takes place in four stages: preparation, exploration, deepening, and transfer. The contents of these stages are as follows (Giordan, 1996; Giordan, 2010; Pellaud et al., 2005):

- **Preparation:** At this first stage, the learner is confronted with a problem related to daily life. He/she tries to solve the problem encountered with his/her existing knowledge. The main issue in the preparation stage is to enable the learner to experience a cognitive conflict. The individual experiencing a cognitive conflict realizes that his/her existing knowledge is insufficient to solve the problem and realizes that he/she needs new information to solve the problem. The learner needs to be made aware that he/she must define the problem correctly and search for a solution.
- **Exploration:** Realizing that he/she needs to construct new knowledge, the individual conducts research and collects data to create solutions for the problem. At this stage, the individual should be directed to benefit from different data sources. The individual collecting data to solve the problem redefines the problem and develops tentative hypotheses.
- **Deepening:** The individual checks the functionality of the solutions he/she has developed within the scope of the new information they have built by tying them out. At this stage, the individual decides on the most consistent solutions and begins to embody the knowledge that forms the basis of the solutions.
- **Transfer:** The individual replaces and assimilates the information he/she created in the previous stage with his/her new knowledge. At this stage, appropriate environments should be created for the individual to practice his/her knowledge. The permanence of knowledge should be ensured by gaining experience to the individual.

The functionality and usefulness of information is determined by its contribution to daily life. The purpose of the allosteric learning approach is to provide practical knowledge and skills by eliminating non-functional knowledge (Pellaud & Eastes, 2003). In other words, the main objective in allosteric learning is to provide experiences to ensure the permanence of knowledge and to encourage the application of gains in daily life. Considering this objective, it is seen that allosteric learning approach has common goals with the social studies course. So much so that social studies course aims to enable students to become effective individuals in daily life by gaining a wide variety of knowledge, skills, and values (Barr et al., 1977; Öztürk & Deveci, 2016).

Learning environments can be variable depending on the dynamic nature of life. This variability can be determinant in students' readiness and motivation. The allosteric learning approach aims to ensure that learning takes place in harmony with the variability in question. For this purpose, it is assumed that allosteric learning approach can be used for effective social studies education. Based on this assumption, the study purposed to improve the academic achievement of students and to equip them with research skills via applications based on the allosteric learning approach in the 5th grade social studies course.

Review of the literature on the subject revealed that the allosteric learning approach was investigated in some studies in the field of education and in the field of architecture. No study was found in the literature in which allosteric learning was used for social studies education. As aforementioned, allosteric learning approach advocates the acquisition of knowledge through experiences, and this would be appropriate for social studies course since its content is based on daily life. On that account, this study was conducted to fill this gap in the literature. It is thought that this study would guide researchers and social studies educators in terms of offering learners effective social studies education. It is also thought that this research would enable social studies educators to realize and use the allosteric learning approach in social studies education.

This study aimed to examine the impact of allosteric learning on the academic achievement and research skills of students in the 5th grade social studies course. The allosteric learning approach was used in the experimental group, while the control group were not taught with the allosteric learning approach. Answers to the following questions were sought in this study:

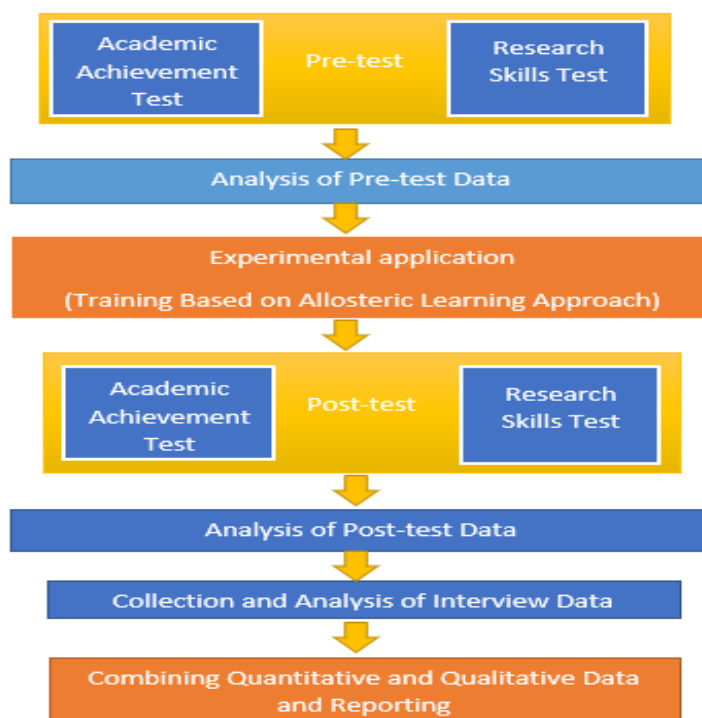
1. Is there a statistically significant difference between the study and control groups in terms of academic achievement levels and research skills levels?
2. What are the students' views on the impact of allosteric learning on their academic achievement and research skills?

## **METHOD**

This study was conducted in a middle-school located in a province of Turkey during the fall-semester of the 2021-2022 academic year. The study was carried out for ten weeks. This mixed-methods research investigated the impact of allosteric learning on students' academic achievement and research skills in the 5th grade social studies course. The mixed-methods design is used in studies that combine statistical and qualitative data (Creswell & Plano-Clark, 2017). The reason for using the mixed-methods design in this study is that test and interview forms were used together in collecting the data, and both statistical and qualitative analysis techniques were employed in the data analysis process.

### **Research Design**

Embedded mixed design was used in this study. Embedded mixed design is intended to support an experimental application with qualitative stages (Creswell & Plano-Clark, 2017). The reason for using the embedded mixed design is to support the pre-test and post-test findings of the research with interview data. The stages followed in the embedded mixed design are shown in Figure 2.



**Figure 2.** Stages followed in the research

As presented in Figure 2, a pre-test was administered in the first stage and the first statistical data were gathered. Then, these data were analyzed and filed. In the next stage, the experimental process of the research was carried out. Following the experimental process, the post-test was conducted, and secondary statistical data were collected. These data were also analyzed, and the qualitative data collection stage was started. The qualitative data were collected through interviews and analysis. At the last stage, statistical and qualitative findings were combined, and the research results were reported holistically.

### The Participants

The participant group of this study consists of 5th grade students, considering that the most appropriate social studies course content for the application of the allosteric learning approach in Turkey is in the fifth grade. There were two groups of participants in this study for collecting quantitative and qualitative data. The quantitative data were gathered from 5th grade students studying at a middle school in Turkey. The criterion sampling method was employed to identify the group. Criterion sampling is a method in which target group that are the subject of the study is selected from those with certain qualifications. In this method, before determining the sample, the required qualifications are decided, and then participants with the decided qualifications are tried to be reached (Büyüköztürk, 2010). While forming the participant group in which quantitative data were gathered, it was decided that the academic achievement of the middle school where the study would be conducted was at a

medium level and that it had at least two groups of 5th graders. There were two groups, one experimental and one control, in the participant group where quantitative data were collected. After deciding on the classes for experimental process, the random technique was employed to specify the study and control groups. Information on the experimental and control groups from which quantitative data were collected is given in Table 1:

**Table 1.** *Information on the study and control groups*

Information	Experimental group		Control group		
	<i>f</i>	%	<i>f</i>	%	
<b>Gender</b>	Female	10	43.48	11	44.00
	Male	13	56.52	14	56.00
	<b>Total</b>	23	100	25	100

Looking at Table 1, it is seen that there were 23 students in the experimental group, 10 females and 13 males, In the control group, on the other hand, there were a total of 25 students, 11 females and 14 males.

The group in which the qualitative data of the study was collected was formed on a voluntary basis. Qualitative data were collected by interviewing five students from the experimental group who volunteered to be interviewed. Each of these students was given a code within the scope of ethical principles. Information about the group from which qualitative data were collected is shown in Table 2:

**Table 2.** *Information on the group from which qualitative data were collected*

Student Code	Duration of the Interview
S1	27' 02''
S2	15' 24''
S3	25' 40''
S4	23' 32''
S5	26' 21''
<b>Total</b>	117' 59''

As presented in Table 2, code names were given to the students. The duration of interviews with students were between 15' 24" and 26' 21". A total of 117' 59" long interviews were conducted with the students.

## **Data Collection**

Quantitative and qualitative tools were used together in collecting the data of this study. Reliability tests were conducted to check the suitability of the statistical tools used for this study. Information on these tools is given under sub-headings.

### ***Science, Technology and Society Achievement Test***

The Science, Technology and Society Achievement Test (STSAT) developed by Şerefli (2020) was employed to determine the impact of the intervention on the academic achievement of the students. Şerefli (2020) found the KR-20 reliability coefficient as .77 in the reliability test he conducted for STSAT. The KR-20 coefficient was found as .74. As the KR-20 value of the test was found to be over .70 (Büyüköztürk, 2010), it was decided that it was reliable for this study. Each item of the test was evaluated between 0 and 1 point. In this context, the highest score that can be obtained from the 27-item test was 27, and the lowest score was 0.

### ***Research Skills Test***

Research Skills Test (RST) developed by Alkan-Dilbaz et al. (2012) was employed to determine the impact of the intervention on the research skill levels of the students. Alkan-Dilbaz et al. (2012) determined the reliability coefficient of KR-20 as .76 in their reliability test for RST. As a result of the reliability test of the RST for this study, the KR-20 coefficient was found to be .73. It was decided that the KR-20 value of the RST was reliable for this study, as it was over .70 (Büyüköztürk, 2010). The RST consists of 20 questions, 19 of which are with four options and 1 with 3 association items. In this study, the item association question was accepted as three questions and it was assumed that the test consisted of a total of 22 items. Each item of the RST was evaluated between 0 and 1 point. In this context, the highest score that can be obtained from the 22-item test is 22, and the lowest score is 0.

### ***Student Interview Form***

The student interview form developed by the researcher was administered to collect the qualitative data of the study. The form was used to analyze the data collected from STSAT and RST in depth within the scope of students' views. During the development of the student interview form, a language expert and three experts who are competent in qualitative research were consulted. Corrections were made in the form depending on the feedback received from the experts. Before the application of the form, a pilot application was conducted with 15 students. The interview form took its final form after the pilot application.

## Data Analysis

To decide on which statistical tests will be used in the analysis of the data collected from STSAT and RST, the kurtosis and skewness of the data were calculated. The calculations are shown in Table 3:

**Table 3.** *Kurtosis and skewness values of data collected from STSAT and RST*

Group	STSAT				RST			
	Pre-test		Post-test		Pre-test		Post-test	
	Skewnes s	Kurtosi s	Skewnes s	Kurtosi s	Skewnes s	Kurtosi s	Skewnes s	Kurtosi s
Experimental	-.44	-.69	-.54	-.05	-.21	-.85	-.82	-.81
Control	1.30	1.05	1.22	.67	.49	-.51	.38	-.65

Table 3 shows that the skewness value of the pre-test scores for the experimental group of the data collected from STSAT was  $-.44$ , and the kurtosis value was  $-.69$ . The skewness value and the kurtosis value of  $1.05$  for the pre-test scores of the data collected from STSAT for the control group were  $1.30$ . The skewness value of the post-test scores in the experimental group of the data collected by STSAT was  $-.54$ , and the kurtosis value  $-.05$ . It can be inferred that the skewness value of the data collected from STSAT and the scores on the post-test for the control group were  $1.22$  and the kurtosis value was  $.67$ .

Table 3 shows that the skewness value of the pre-test data collected from RST for the experimental group was  $-.21$  and the kurtosis value was  $-.85$ . The table shows that the skewness value of the pre-test data collected from RST for the control group was  $.49$  and the kurtosis value was  $-.51$ . The skewness value of scores on the post-test of the data collected from RST in the experimental group was  $-.82$ , and the kurtosis value was  $-.81$ . The scores on the post-test collected from RST for the control group were found to be  $.38$  for skewness and  $-.65$  for kurtosis.

It was revealed that the data showed a normal distribution due to the fact that the values obtained from the data via pre-test and post-test collected by means of STSAT and RST were between  $-1.5$  and  $1.5$  (Tabachnick & Fidell, 2019).

Levene test was employed to check whether the pre-test and post-test data collected from STSAT and RST were homogeneously distributed. The values are shown in Table 4:

**Table 4.** *Results of homogeneity test of pre-test and post-test scores of data collected from STSAT and RST*



Test	Pre-test				Post-test			
	Levene statistics	df1	df2	p	Levene statistics	df1	df2	p
STSAT	1.75	1	46	.19	.02	1	46	.89
RST	2.95	1	46	.09	2.18	1	46	.14

Table 4 shows that the p value of the pre-test data was .19, and the p-value of the post-test data was .89 based on the homogeneity test applied to the data collected by STSAT from the experimental and control groups. In addition, as a result of the homogeneity test applied to the data collected with RST from the two groups, it can be inferred that the p value of the data coming from pre-test was .09, and the p value of the post-test data was .14. It was determined that the data were homogeneously distributed due to the fact that the p values were greater than .05 (Kilmen, 2015).

Based on the skewness and kurtosis values and homogeneity tests, parametric tests were decided to be used in analyzing the data obtained from pre-test and post-test. Then, which parametric tests to use were investigated. To use covariance analysis, in-group regression coefficients in the experimental and control groups were examined and it was determined that they were equal. Depending on the results, t-test and covariance analysis were used in the analysis of statistical data.

Content analysis was used to analyze the qualitative data of this study. Content analysis is an analysis method that aims to reach conceptual and relational structures regarding the research question from the collected data (Creswell & Poth, 2016). In the process of analyzing the qualitative data, expert opinion was sought on whether the analysis was done in the correct manner. In this context, the codes and themes created by the analysis of qualitative data and the raw form of the data were sent to a researcher who is competent in qualitative study and his opinions were taken into account.

### Experimental Application Process

The experimental process of this study was carried out in the fall semester of the 2021-2022 academic year. In the experimental process, lesson plans based on the allosteric learning approach, which were designed on the basis of the content of the Science, Technology and Society part of the social studies course, were used in the experimental group. In the control group, the education style prescribed by the Ministry of National Education (MoNE) was continued.

## Validity and Reliability

Various stages were undergone in this study to ensure validity and reliability. These stages are as follows:

- Reliability tests were conducted to check the suitability of STSAT and RST, which are employed in the use of statistical data for this study.
- In the process of developing the interview form used to collect the qualitative data of this study, opinions of four experts were taken into account.
- A pilot application of the interview form was made.
- The codes and themes obtained from the qualitative data of the study and one-fourth of the raw data were presented to the expert's opinion and opinions were received on whether the analysis was done in the correct manner.

## FINDINGS

In this study, which aims to examine the effect of allosteric learning on students' academic achievement and research skills in the 5th grade social studies course, statistical and qualitative data were collected. Firstly, the pre-test data and then the post-test data were analyzed and interpreted. Subsequently, the qualitative data were analyzed and combined with the statistical data, and the findings were revealed. The findings are "the impact of allosteric learning approach on students' academic achievement in social studies course", "the impact of allosteric learning in social studies course on students' research skills" and "students' views on the effect of allosteric learning approach on students' academic achievement and research skills", presented under three headings.

### Findings and Comments on the Impact of Allosteric Learning Approach on Students' Research Skills in Social Studies Course

The impact of allosteric learning approach on the academic achievement of students was investigated in this study, and STSAT was applied to the experimental and control groups as a pre-test before the experimental procedure. Descriptive statistics regarding the obtained findings are presented in Table 10.

**Table 10.** *Descriptive statistics of the scores on the pre-test of the experimental and control groups from STSAT*

<b>Groups</b>	<b>n</b>	<b><math>\bar{x}</math></b>	<b>sd</b>
Experimental	23	12.43	2.08

Control	25	12.32	3.14
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When Table 10 is examined, it can be inferred that the average scores of the students in the pre-test in the experimental group in which the allosteric learning approach was applied was 12.43, and the standard deviation was 2.08. It is seen that the average scores of the students on the pre-test in the control group, in which the allosteric learning approach was not applied, was 12.32, and the standard deviation was 3.14.

To examine whether the difference between the pre-test scores of the experimental and control groups is significant or not, t-test was administered for independent samples. The obtained results are displayed in Table 11.

**Table 11.** *The results of the t-test for independent samples applied between the scores on the pre-test of the experimental and control groups from the STSAT*

Group	n	$\bar{x}$	sd	df	t	p
Experimental	23	12.43	2.08	46	.15	.88
Control	25	12.32	3.14			

Table 11 reveals that the average scores of the pre-test of the experimental group ( $\bar{x}$ ) was 12.43; while the average score of the control group was 12.32. As a result of the t-test for independent samples, the degrees of freedom were found to be 46, the t value was .15, and the p value was .88. It shows that there is no significant difference between the pre-test results of the experimental and control groups ( $t(46) = .15$ ;  $p = .88 > .05$ ) depending on the values. Since the results of the experimental and control groups were similar, it was determined that the academic achievement levels of the groups before the experimental procedure were close.

Following the experimental procedure, STSAT was administered to the experimental and control groups as a post-test. Descriptive statistics for the results obtained are shown in Table 12:

**Table 12.** *Descriptive statistics of the post-test scores of the experimental and control groups from STSAT*

Groups	n	$\bar{x}$	sd
Experimental	23	21.30	2.67
Control	25	12.40	2.74

When Table 12 is examined, the post-test average score of the students in the experimental group to whom the allosteric learning approach was applied was 21.30, and the standard

deviation was 2.67. The table shows that the STSAT post-test average scores of the control group, in which the allosteric learning approach was not applied, was 12.40 and its standard deviation was 2.74.

Covariance analysis was conducted to reveal the impact of the experimental procedure on the academic achievement of the students. Prior to covariance analysis, the equality of within-group regression coefficients was examined. The values achieved are displayed in Table 13:

**Table 13.** Results regarding the interaction between the co-variable pre-test scores and the experimental and control groups

Source of variation	Sum of squares	df	Mean of squares	F	p
Corrected model	1188.25	3	396.08	177.09	.00
Group	37.32	1	37.33	16.69	.00
Pre-test	190.91	1	190.91	85.36	.00
<b>Group x pre-test</b>	<b>.13</b>	<b>1</b>	<b>.13</b>	<b>.06</b>	<b>.81</b>
Error	98.41	44	2.23		
<b>Total</b>	<b>1286.66</b>	<b>47</b>			

As presented in Table 13, the p value of the group x pre-test interaction was calculated as .81. A p value above .05 ( $F(1; 44) = .06$ ;  $p = .81 > .05$ ) means that the within-group regression curves for the experimental and control groups were equal.

The results of the covariance analysis performed to compare the post-test scores of the groups are shown in Table 14:

**Table 14.** Results of covariance analysis for the comparison of post-test scores

Source of variation	Sum of squares	df	Mean of squares	F	p	$\eta^2$	Observed power
Corrected model	1188.13	2	594.06	271.29	.00	.92	1.00
Pre-test	238.33	1	238.33	108.84	.00	.71	1.00
Group	928.75	1	928.75	424.14	.00	.91	1.00
Error	98.53	45	2.19				
<b>Total</b>	<b>1286.66</b>	<b>47</b>					

In Table 14, it is seen that the p value between the test scores (corrected according to the pre-test scores) of the experimental and control groups was .00. The value was less than .05 and this indicates that the experimental procedure gives a statistically significant result ( $F(1; 45) = 424.14; p=.00 < .05$ ). In other words, it shows that there was a significant difference between the pre-test and post-test scores of the experimental and control groups. The effect size of the experimental procedure has also been calculated. The table shows that the effect size of the experimental treatment was .91, in other words, the effect size of the experimental treatment was large.

Table 14 also includes the power of the experimental process. The table 14 shows that the power of the experimental procedure was 1.00 and in this context, the  $H_0$  hypothesis was rejected by 100%. In this respect, it has been concluded that the allosteric learning approach increases the academic achievement levels of the students.

### **Findings and Comments on the Impact of Allosteric Learning Approach on Students' Research Skills in Social Studies Course**

In the study, which aimed to reveal the effect of allosteric learning approach on students' research skills, RST was administered to the experimental and control groups of this study as a pre-test prior to the experimental procedure. Descriptive statistics regarding the obtained results are shown in Table 15 and then interpreted.

**Table 15.** *Descriptive statistics of the pre-test scores of the experimental and control groups from RST*

<b>Groups</b>	<b>n</b>	<b><math>\bar{x}</math></b>	<b>sd</b>
Experimental	23	11.91	2.21
Control	25	12.60	2.94

Table 15 shows that the average of the test scores of the students in the experimental group in which the allosteric learning approach was applied was 11.91, and the standard deviation was 2.21. It is seen that the average of the test scores of the students from RST in the control group, in which the allosteric learning approach was not applied, got 12.60 and the standard deviation was 2.94.

To reveal whether there was a significant difference between the test scores of the experimental and control groups, the t-test for independent samples, one of the parametric tests, was performed. The obtained results are shown in Table 16.

**Table 16.** *Results of the t-test for independent samples applied between the pre-test scores of the experimental and control groups from RST*

Group	n	$\bar{x}$	sd	df	t	p
Experimental	23	11.91	2.21	46	-.91	.37
Control	25	12.60	2.94			

Looking at Table 16, the experimental group's test mean score ( $\bar{x}$ ) of the test was 11.91, while the control group was 12.60. The findings of the t-test for independent samples showed that the degrees of freedom were 46, the t value was -.91, and the p value was .37. Based on these values, it can be said that there was no significant difference between the pre-test results of the experimental and control groups ( $t(46) = -.91; p = .37 > .05$ ). Since the results of the experimental and control groups were similar, it was determined that the research skill levels of the groups before the experimental procedure were close.

To reveal the impact of allosteric learning approach on students' research skills, RST was administered to the experimental and control groups as a post-test after the experimental procedure. Descriptive statistics for the obtained results are shown in Table 17:

**Table 17.** *Descriptive statistics of the post-test scores of the experimental and control groups from RST*

Groups	n	$\bar{x}$	sd
Experimental	23	17.30	4.06
control	25	14.84	3.41

Table 17 shows that the average score of the students in the experimental group to whom the allosteric learning approach was applied was 17.30, and the standard deviation was 4.06. It is seen that the RST post-test average scores of the control group, in which the allosteric learning approach was not applied, was 14.84 and its standard deviation was 3.41.

Covariance analysis was conducted to reveal the impact of the experimental procedure on the research skills of the students. Before the test, it was checked whether the within-group regression coefficients were equal in the experimental and control groups. The obtained results are presented in Table 18.

**Table 18.** *Results regarding the interaction between the co-variable pre-test scores and the experimental and control groups*

Source of variation	Sum of squares	df	Mean of squares	f	p
Corrected model	159.99	3	53.33	4.22	.01
Group	45.09	1	45.09	3.57	.06
Pre-test	35.54	1	35.54	2.81	.10
<b>Group x pre-test</b>	<b>24.29</b>	<b>1</b>	<b>24.29</b>	<b>1.92</b>	<b>.17</b>
Error	554.98	44	12.61		
<b>Total</b>	<b>714.98</b>	<b>47</b>			

As seen in Table 18, the p value of the group x pre-test interaction was calculated as .17. A p value above .05 ( $F(1; 44)=1.92$ ;  $p= .17 > .05$ ) means that the within-group regression curves for the experimental and control groups were equal.

The results of the covariance analysis performed to compare the post-test scores of the experimental and control groups are presented in Table 19.

**Table 19.** Results of covariance analysis for the comparison of post-test scores

Source of variation	Sum of squares	df	Mean of squares	F	p	$\eta^2$	Observed Power
Corrected model	135.70	2	67.85	5.27	.01	.19	.81
Pre-test	62.95	1	62.95	4.89	.03	.09	.58
Group	90.36	1	90.36	7.02	.01	.13	.73
Error	579.27	45	12.87				
<b>Total</b>	<b>714.98</b>	<b>47</b>					

As seen in Table 19, the p value between the test scores (corrected according to the pre-test scores) of the experimental and control groups was .01. The value is less than .05 and this indicates that the experimental procedure gives a statistically significant result ( $F(1; 45) = 7.02$ ;  $p=.01 < .05$ ). In other words, it shows that there was a significant difference between the pre-test and post-test scores of the experimental and control groups. As seen in the table, the impact size of the experimental procedure has also been calculated. It is seen that the impact size of the intervention is .13, meaning the impact size of the intervention is medium.

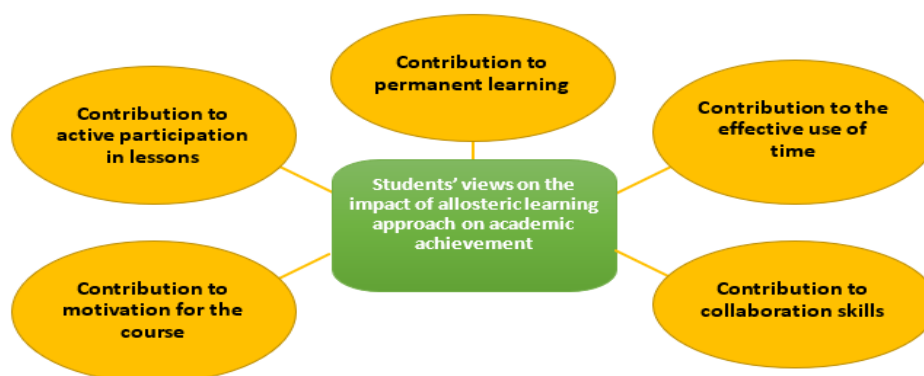
Table 19 also includes the power of the experimental process. When Table 19 is examined, it is seen that the power of the experimental procedure performed was .73 and, in this context, the

h0 hypothesis was rejected by 73%. Within the scope of the results, it was determined that the allosteric learning approach increased the research skill levels of the students.

### **Findings and Comments on Students' Views on the Impact of Allosteric Learning Approach on Their Academic Achievement and Research Skills**

The views of the students on the impact of allosteric learning approach on their academic achievement and research skills were collected. The analyzed data were supported with direct quotations.

The findings regarding the students' views on the impact of the allosteric learning approach on academic achievement are shown in Figure 3:



**Figure 3.** *Students' views on the impact of allosteric learning approach on academic achievement*

As seen in Figure 3, the findings regarding the students' views on the impact of allosteric learning on academic achievement in the social studies course reveal that the approach contributes to the following areas: motivation for the course, active participation in lessons, permanent learning, effective use of time, and collaboration skills.

It was revealed that some of the interviewed students believed that the allosteric learning approach contributed to permanent learning. S3 have made remarkable statements regarding the impact of allosteric learning on permanent learning: *"When I learned something in the previous lessons, I forgot it after a while. Since I had to learn on my own in these lessons (social studies based on allosteric learning), I started not to forget what I learned"*. Similarly, S1 compared the lessons in the experimental process with the lessons before and stated that the social studies lessons conducted with the allosteric learning approach contributed more to the permanence of learning than the previous lessons by saying: *"I remember the topics that we*



*have learned during this semester. I do not forget easily. Before, it was not like this. I just forgot them.."*

It was determined that some students thought that allosteric learning is an approach that contributes to the effective use of time. For example, S2 said, *"We were doing a lot of work in the lessons, but we had little time. When time was short, we had to do everything just in time. I also learned to fit things into time."* He thought that the allosteric learning approach taught him to use time effectively.

It was also found that some of the students believed allosteric learning is an approach that directs them to collaborate in lessons. Making striking statements in this context, S5 made the following statements on the subject:

*"Our every lesson is spent sitting on a chair like this and listening to the teacher. So, everyone minds their own business. Previously, we didn't do it like the lessons in this semester. Everyone was doing their own work. During this period, we were doing things together, and this is very easy. This is how we should always work. It's much easier when you do it together. Time is not wasted too much. Things are done right, too."*

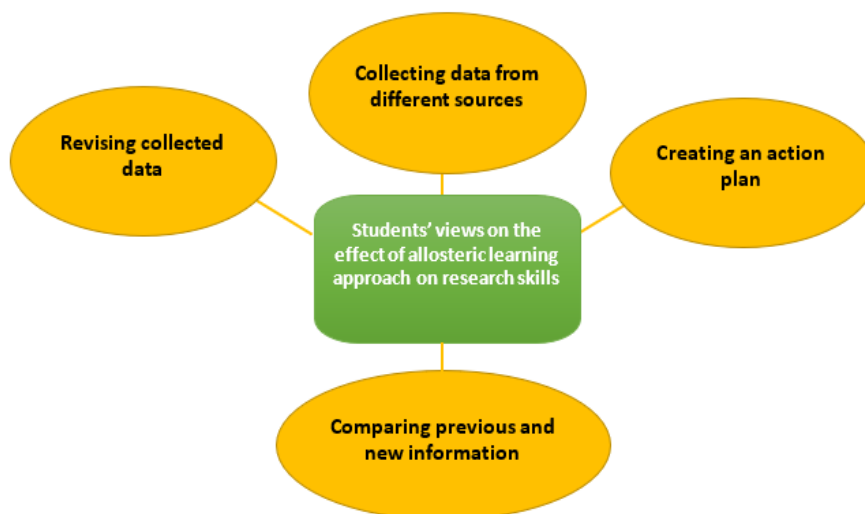
Considering the statements of S5; it was determined that allosteric learning approach led students to collaborate, and in this context, he thought that students were more successful in doing activities related to the lessons.

Some students stated that allosteric learning is an approach that contributes to their motivation. One of these students, S2, expressed his opinion in this regard, *"When we learn like this (based on the allosteric learning approach), we willingly come to classroom. I even wished the lessons were longer"*. A similar view that allosteric learning contributes to the motivation for the lesson came from S3. S3 stated, *"Our lessons have always been fun. We had fun in the lessons. We were having fun and learning at the same time. We liked the lessons."*

It has been found that some students actively participated in the lesson, credits to the allosteric learning approach. S1 said, *"When the class is not boring, people are eager to attend the class. Well, I'm telling you frankly. In the previous lessons, I did not want to attend. I was bored. I am not bored in these lessons. I want to attend more. I always attended"*. This shows that classes that are conducted with the allosteric learning approach increases students' motivation.

Analysis of the interview data showed that social studies lessons conducted with the allosteric learning approach contributed to the students in terms of: motivation for the course, active participation in lessons, permanent learning, effective use of time, and collaboration skills.

Students' views were sought regarding the effect of allosteric learning approach on students' research skills. The findings are shown in Figure 4:



**Figure 4.** *Students' views on the effect of allosteric learning approach on research skills*

From Figure 4, it can be seen that the students' views on the effect of the allosteric learning approach on research skills reveal that this approach made the students learn to collect data from different sources, create action plan while doing research, compare previous and new information, and revise the collected data.

It was determined that some of the interviewed students in the study thought that they learned to collect data from different sources due to the social studies courses conducted with the allosteric learning approach. The most striking expressions were used by S4 in this regard: *"It is not enough to learn only from the textbook. For example, we were given problems in the lessons that it was impossible to solve them by referring to only one book. At that time, our teacher used to say to us, 'use your tablets or ask me or ask your friends.'"* S4 indicated that the allosteric learning approach improved her research skills by saying: *"This has also made a habit for me. I no longer do research only with a book. Because I can certainly find answers elsewhere. There's an easy way to do it"*

Some students stated that they realized that they needed to create an action plan while doing research, inspired by the activities implemented in the experimental process of the research. For example, S3 said, *"When we want to solve a question, first of all, we should set up a plan for ourselves. So what are we going to do? How are we going to do it? Where do we start? We need to make things clear from the very beginning. Now I understand this well"*. This statement shows that the student gained awareness about the need to create an action plan while doing research in the experimental process. This student also made clear that she reflected her gains

in the experimental process to her behaviors by saying: *"For example, at first, I was doing things without planning. Then I realized that it does not work like this. I said to myself 'I have to act smart'. After that, I set up a plan for everything from the very beginning. I acted according to the plan"*.

S5, one of the students interviewed, said that he started to compare old and new information while doing research as it was done during the social studies lessons conducted with the allosteric learning approach, and he realized that some of the things he knew were wrong and he corrected them. The statements of S5 in this context are as follows:

*"I think it is very important for a person to do his/her own research. Turns out, a lot of what I thought was right turned out to be wrong. While doing research, I noticed some of them. Since then, I started checking everything I knew while doing research. So, I was thinking to myself - let's see if this is the case? Is this information wrong? - This is how I corrected a lot of my misinformation. I always do that now. In fact, it would be more accurate to say that I do it when I am not sure. Because people have doubts about certain things. The person asks himself: "Is it right in this way?" In those cases, I check whether what I know is right or wrong."*

Looking at the statements of S5, it is understood that S5 has developed a point of view that he has gained the habit of checking his past knowledge, credits to the allosteric learning approach.

It was found that some students gained the habit of revising the collected data while doing research during the experimental process. S4 said: *"the teacher used to ask us: 'what happens in this case or that case?' Since then, I became aware that I need an organized system. Ok, I was collecting a lot of information, but it was confusing which information to use for what. Because there was no order"*. This statement reveals that the student was complaining about the limitations caused by unorganized collected data in the first lessons where the allosteric learning approach was applied. S4 then said, *"Now I don't do that anymore. When I want to solve a problem, I do research. I categorize everything. For example, I say that this information is required for this, that information is required for that, etc. Then, when I combine them all, I feel very relieved."* From this statement of S4, it is understood that she became conscious of the need to organize the data collected while doing research.

Based on the findings obtained by analyzing the interview data, it was determined that the students thought the social studies lessons conducted with the allosteric learning approach improved their research skills by contributing to the subjects of collecting data from different sources, creating an action plan, comparing old and new information, and revising the collected data.

## DISCUSSION

The findings were analyzed and interpreted. The findings are discussed in the light of similar studies in the literature as presented below.

It was concluded that the allosteric learning approach in social studies course increased the academic achievement of the students. In the literature review conducted to discuss the result in question, it was seen that there were studies that reached similar results. Berkant and Gökçedağ (2019) determined that science and technology education based on allosteric learning increased the academic achievement of students. Similarly, Topbaş (2013) concluded that allosteric learning is an approach that contributes to the realization of educational goals. Berkant and Baysal (2017), in their study based on teacher opinions, determined that teachers see allosteric learning as an effective approach in English education.

The findings of this study revealed that social studies courses based on allosteric learning improve the research skills of the students. Studies with similar results were found in the literature. Koç-Akran and Babaoğlu (2019) argued that allosteric learning was effective in gaining students reflective thinking skills. Koç and Tavukçu (2015) examined the education based on the allosteric learning approach within the scope of teachers' opinions and concluded that the teachers thought that this approach gave students cooperation and problem-solving skills. Kanca (2020) reported that allosteric learning provides students with effective thinking skills.

It was revealed in this study that students see allosteric learning as an approach that improves academic achievement by contributing to permanent learning, using time effectively, collaborating, increasing motivation towards the course, and actively participating in the lesson. This finding is in line with Gökçedağ (2017), who argued that the allosteric learning approach provides permanent learning in students. Moreover, Babaoğlu (2018) concluded that this approach provides permanent learning in the study he carried out within the scope of the allosteric learning-based English course. Additionally, Şahin-Doğruer (2020) determined in his study that allosteric learning increases the motivation and academic achievement of learners.

It was concluded in this study that the students viewed the allosteric learning as an approach that increased their research skill levels by contributing to data collection from different sources, creating an action plan, comparing old and new information, and revising the collected data. This finding supports Koç-Akran and Babaoğlu (2019) who determined that allosteric learning not only provides students with various skills, but also makes them competent in research. Furthermore, Kanca (2020) reported that allosteric learning contributes to students in benefiting from wide variety of data sources.

## CONCLUSION

This study, which aimed to investigate the impact of allosteric learning on students' academic achievement and research skills in the 5th grade social studies course, was carried out with an embedded mixed design. Both quantitative and qualitative data were collected and analyzed in the study. It was revealed by this study that the allosteric learning approach increased the students' academic achievement and research skills. Moreover, the participating students thought that allosteric learning increased their academic achievement levels and equipped them with research skills. Various recommendations were made depending on the findings of the present study. Moreover, the impact of allosteric learning approach in the 5th grade social studies course was investigated in this study. The impact of allosteric learning approach on students' academic achievement in social studies course can be examined at different grade levels. In this study, the impact of allosteric learning approach on academic success and research skills in social studies course was investigated as well. The impact of the allosteric learning approach can be examined in studies that aim to provide students with a wide variety of skills in social studies lessons. The impact of allosteric learning on academic achievement in social studies course was also investigated in this study. Studies can be conducted to investigate the contribution of allosteric learning to students' academic achievement in different courses. Lastly, this study also investigated the impact of allosteric learning on gaining research skills in social studies course. The impact of allosteric learning in different courses can be examined in providing students with a wide variety of skills.

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