

## RESEARCH ARTICLE

# The Effect of Science Activities Supported with Verbal Intelligence Games on the Problem Solving and Scientific Reasoning Skills of Prospective Teachers\*

İrem Bertizlioğlu<sup>1</sup>  • İbrahim Yüksel<sup>2</sup> 

<sup>1</sup>Gazi University, Institute of Educational Sciences, Department of Math and Science Education, Ankara/Türkiye

<sup>2</sup>Gazi University, Faculty of Education, Department of Math and Science Education, Ankara/Türkiye

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## ABSTRACT

The current study was carried out to determine the effect of science activities supported with verbal intelligence games on the problem solving and scientific reasoning skills of prospective teachers. In the study, a pre-test-post-test control group quasi-experimental design was used. Some applications were conducted with 44 prospective teachers, forming the test and control group in the research. This study was conducted in the intelligence games course taking place in the science teaching program applied in a state university. While the program taught in the intelligence games course in the curriculum of science teaching was used in the control group, science activities supported with verbal intelligence games were applied in the test group. The current study allowed to investigate the verbal intelligence games and the intelligence games forming five sub-dimensions other than verbal intelligence games (reasoning processing games, strategy games, intelligence questions, geometrical mechanical games, memory games) in terms of problem-solving and scientific reasoning skills variables. Verbal intelligence games used in the study were developed by the researcher and applied to prospective teachers for seven weeks. "The Scale of Problem-Solving Skills for Adults" developed by Yaman and Dede (2008) to determine the effect of science activities supported with verbal intelligence games on the problem-solving skills was used and "The Scientific Reasoning Skills Test" prepared by Yüksel (2015) to determine their effect on the scientific reasoning skills was used. Problem-solving skills of the prospective teachers who were applied verbal intelligence games were positively affected in the study. When it comes to the pre-test and post-test data of the scale of problem-solving skills for adults of the test and control groups, no statistically significant difference was found even though mean score of the test group was higher than that of the control group. In the test group, reasoning skills at the prospective teacher who were applied verbal intelligence games were affected positively.



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## 1. Introduction

Deep rooted games are of a valuable place in human life, particularly in children's life. Games are not only an effective

learning media, but they also have an active place in the cognitive, physical and affective development of children (Öztürk, 2007). Intelligence games are of a vital place in the integration of games to education. One of the trials of this

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✉ Correspondence

E-mail address: irembtrzl@gmail.com

integration was carried out with the publication and application of Secondary School and İmam Hatip Secondary School Intelligence Games Course Curriculum (MoNE, 2013). In a study by Şen (2020), it was pointed out that intelligence games were included in the curriculum to support the cognitive development of children, finding a solution for the problems encountered, to allow them make the most suitable decision in a short time and to make a social interaction by playing individually or in a group.

Intelligence games course is taught in six sub-dimensions under intelligence games in the curriculum. One of them is verbal games. It is expressed in the curriculum that as well as benefiting from vocabulary in different ways, children also make use of logical deductions thanks to verbal games. Intelligence games course focuses on the development of affective features of problem solving, communication and reasoning at children. Problem solving forms the basis of intelligence games course and its activities (MoNE, 2013).

Games, especially intelligence games, are connected to problem solving and reasoning. Li et al., (2012) indicated that playing games is a continual observation and problem-solving process. In their studies, Bottino et al. (2013) carefully and well-designed intelligence games could contribute to the persistence of reasoning and problem-solving skills at students. Upon taking these cases into consideration, it is thought that gamification of the subject matters taking place in the verbal parts in the science curriculum using verbal intelligence games would contribute to individuals both in cognitive fields and allow them to carry on the learning process in the direction of their wishes.

The current study is of importance in terms of revealing whether supporting the learning process with intelligence games, activating a great many skills, using verbal intelligence games in teaching verbal subjects, which are significant in number, in science course will provide an advantage for individuals in various senses. Teachers are of significant and vital tasks in supporting the learning process with benefits, helping learners develop different fields. Devcioğlu and Karadağ (2014) pointed out in their studies that teacher's inadequacy in the course and not teaching the course as expert teachers are frequently expressed points for the problems encountered in intelligence games course. The more information one has regarding intelligence games, the better the benefits that will be provided through intelligence games could be transferred to students. It is thought that the prospective teachers who can improve themselves in intelligence games will be in an advantageous position for the integration of these games to the course in the future.

The current study is different from other studies in some respects. Studies were mostly carried out with student groups regarding intelligence games (Aşuluk, 2020; Coşanay & Kasa Ayten, 2023; Doğan, 2023; Güvenç Çalışkan, 2024; Kurbal,

2015; Özen, 2023; Sarı, 2024; Usta et al., 2023; Yılmaz, 2019; Zengin Kılavuz, 2024). In a study carried out by Deniz (2024), to investigate post-graduate theses regarding mental and intelligence games in Türkiye there are some findings supporting this idea. In the related study, upon the review of the distribution of the theses prepared in the field of mental and intelligence games, it was indicated that the studies were carried out with students at the rate of 66.67%, with teachers at the rate of 21.43%, with student guardians at the rate of 3.57% and with prospective teachers at the rate of 2.38%. The current study was conducted with the prospective teachers having their education at the university. The reason why prospective teachers were chosen results from the idea that teachers are at the key point for students who would be able benefit from the uses of intelligence games could offer. The study was carried out in the intelligence games course taking place in the science curriculum applied at a state university. This study is of importance in terms of the fact that it investigates verbal intelligence games and five sub-dimensions out of verbal intelligence games (reasoning processing games, strategy games, intelligence questions, geometrical mechanical games, memory games) with the variables of problem-solving skills and scientific reasoning skills.

The problem sentence of the current study comprises the question of "Is there an effect of verbal intelligence games supported with science activities on the problem-solving skills and scientific reasoning skills of prospective teachers?"

### 1.1. Sub-Problems

1. Is there a statistically significant difference between the pre-test scores of the scale of problem-solving skills for adults for the test and control groups?
2. Is there a statistically significant difference between the pre-test-post-test scores of the scale of problem-solving skills for adults for the test group?
3. Is there a statistically significant difference between the pre-test-post-test scores of the scale of problem-solving skills for adults for the control group?
4. Is there a statistically significant difference between the post-test scores of the scale of problem-solving skills for adults for the test and control groups?
5. Is there a statistically significant difference between the pre-test scores of the scientific reasoning skills test for the test and control groups?
6. Is there a statistically significant difference between the pre-test-post-test scores of the scientific reasoning skills test for the test group?
7. Is there a statistically significant difference between the pre-test-post-test scores of the scientific reasoning skills test for the control group?

8. Is there a statistically significant difference between the post-test scores of the scientific reasoning skills test for the test and control groups?

## 2. Method

The research was discussed in the Ethical Commission of Gazi University Rectorship with a date of 09.10.2024 and no of 16 and ethically approved. The date and number of the related documents is 21.10.2024-E.1069674.

The current study is a quantitative research with a pre-test-post-test paired control group design from quasi-experimental designs. In this design, the paired groups are assigned to process groups randomly. In this design, a different process is applied to the test group from the control group, while the control group is carried on without any change (Büyüköztürk et al., 2022).

### 2.1. Population/Sampling

The sampling of the study was made up of 44 prospective teachers forming the test group (n=22) and the control group (n=22) studying in the section of science education of the department of mathematics and science education at a state university in the city of Ankara. The test and control groups were chosen randomly in the research. The prospective teachers studying at the section of science education of the department of mathematics and science education at a state university in the city of Ankara comprise the population of the study.

### 2.2. Data Collection Tools

Within the scope of the study, “The Scientific Reasoning Skills Test” prepared by Yüksel (2015) to determine their effect on the scientific reasoning skills and “The Scale of Problem-Solving Skills for Adults” developed by Yaman and Dede (2008) to determine the effect of science activities supported with verbal intelligence games on the problem-solving skills were used.

#### 2.2.1. The scientific reasoning skills test

The Scientific Reasoning Skills Test prepared by Yüksel (2015) was examined by field expert instructors in the field and arranged. The validity and reliability calculations of the test was made and applied to 303 students. As a result of the analysis of the data obtained, Cronbach Alpha reliability coefficient was

found .76. The test was made up of 26 questions in total, 19 semi-open-ended, seven open-ended. Total 26 questions were examined in seven sub-dimensions as conservation laws (3), proportional thinking (4), determining and controlling variables (4), combinational thinking (4), correlational thinking (4), probability thinking (4) and hypothetical thinking (3).

#### 2.2.2. The scale of problem-solving skills for adults

The scale developed by Yaman and Dede (2008) to determine the problem-solving skill levels of adults is a Likert-type scale. Numbering in the scale corresponds to 1=Never, 2=Rarely, 3=Sometimes, 4=Frequently, 5=Always. The scale was applied to 550 adults. As a result of the findings obtained in the scale, Alpha reliability coefficient was found .88. The total 18 questions were examined in five sub-dimensions as thinking of the solution effects of the problem (5), problem solving through modelling (3), searching for alternative solutions (4), commitment in solving the problem encountered (3), analysing the problem encountered (3).

### 2.3. Application Process

The activities in the current study were prepared for the prospective teachers studying at the section of science education and forming the test group. As a result of the revision of the literature regarding the national and international books, related articles and theses, the activities in the research were originally formed by the researcher. To make the activities more understandable, instructions were added before them. The games of “Finding the Password, Grouping Vocubular, Mixed Letters, Vocabulary Circle and Word Hunt” were determined by the researcher and depending on feedbacks from the expert educators, the games were finalized. The science activities developed with verbal intelligence games in the research were shaped under the headings of biology, physics, chemistry, nature education, science history, astronomy, renewable energy.

### 2.4. Data Collection Process

Data collection process of the test and control groups in the research was completed in nine weeks. The data of the study was collected in 2024-2025 academic year. The application and data collection process of the test and control groups were given below in detail:

**Table 1.** The application and data collection process the test and control groups.

Weeks	Test Group	Control Group
Week 1	Application of Pre-tests	Application of Pre-tests
Week 2	Activity-Based Science Education in the Biology Subjects Supported with Verbal Intelligence Games	Current Science Education Undergraduate Curriculum (Intelligence Games Course)
Week 3	Activity-Based Science Education in the Physics Subjects Supported with Verbal Intelligence Games	Current Science Education Undergraduate Curriculum (Intelligence Games Course)
Week 4	Activity-Based Science Education in the Chemistry Subjects Supported with Verbal Intelligence Games	Current Science Education Undergraduate Curriculum (Intelligence Games Course)
Week 5	Activity-Based Science Education in the Nature Education Subjects Supported with Verbal Intelligence Games	Current Science Education Undergraduate Curriculum (Intelligence Games Course)
Week 6	Activity-Based Science Education in the Science History Subjects Supported with Verbal Intelligence Games	Current Science Education Undergraduate Curriculum (Intelligence Games Course)
Week 7	Activity-Based Science Education in the Astronomy Subjects Supported with Verbal Intelligence Games	Current Science Education Undergraduate Curriculum (Intelligence Games Course)
Week 8	Activity-Based Science Education in the Renewable Energy Subjects Supported with Verbal Intelligence Games	Current Science Education Undergraduate Curriculum (Intelligence Games Course)
Week 9	Application of Post-tests	Application of Post-tests

## 2.5. Data Analysis

The quantitative data obtained in the research was analysed using Jamovi 2.6.19 application. Normality test (Shapiro-wilk), homogeneity test (Levene), dependent t-test, independent t-test, ANCOVA test were used during the analyses and the data obtained was given as tables in the findings part. The normality and homogeneity test results of the quantitative data collection tools used were given below.

**Table 2.** Pre-test normality (Shapiro-Wilk) results of the scale of problem-solving skills for adults for test and control groups.

Group	N	W	p
Test	22		
Control	22	.97	.38

As is given in Table 2, since it is  $p > .05$ , normality assumption is met.

**Table 3.** Pre-test homogeneity (Levene) results of the scale of problem-solving skills for adults for test and control groups.

Group	N	F	df	df2	p
Test	22				
Control	22	.02	1	42	.88

As is given in Table 3, since it is  $p > .05$ , homogeneity assumption is met.

**Table 4.** Pre-test normality (Shapiro-Wilk) results of the scientific reasoning skills test for test and control groups.

Group	N	W	p
Test	22		
Control	22	.97	.37

As is given in Table 4, since it is  $p > .05$ , normality assumption is met.

**Table 5.** Pre-test homogeneity (Levene) results of the scientific reasoning skills test for test and control groups.

Group	N	F	df	df2	p
Test	22				
Control	22	3	1	42	.09

As is given in Table 5, since it is  $p > .05$ , homogeneity assumption is met.

## 3. Findings

The analyses of the findings regarding the questions taking place in the research problem were given as tables in this part. Firstly, normality and homogeneity assumptions were examined for the data concerning problem-solving skills. Since the assumptions were met, parametric tests were carried out. Following that, normality and homogeneity assumptions were examined for scientific reasoning skills test. Since there was a significant difference between the pre-test data of the test and control groups even though normality and homogeneity were met, ANCOVA test was conducted.

### 3.1. Findings Regarding First Sub-Problem

The first sub-problem of the study is “Is there a statistically significant difference between the pre-test scores of the scale of problem-solving skills for adults for the test and control groups?”. To understand whether there was a statistically significant difference between the pre-test scores of the scale of problem-solving skills for adults for the test and control groups, the data was analysed using independent t-test, one of the parametric tests.

**Table 6.** Pre-test independent t-test results for the scale of problem-solving skills for adults for the test and control groups.

Group	N	$\bar{X}$	t	df	p
Test	22	64.68	-0.70	42	.49
Control	22	66.45			

Independent t-test results in Table 6 show that since it was  $p > .05$ , no significant difference was found between the pre-test mean scores for the problem-solving skill of the test and control groups.

### 3.2. Findings Regarding Second Sub-Problem

The second sub-problem of the study is “Is there a statistically significant difference between the pre-test-post-test scores of the scale of problem-solving skills for adults for the test group?”. To understand whether there was a statistically significant difference between the pre-test scores of the scale of problem-solving skills for adults for the test and control groups, the data was analysed using dependent t-test, one of the parametric tests.

**Table 7.** Pre-test-post-test dependent t-test results for the scale of problem-solving skills for adults for the test group.

Test	N	$\bar{X}$	t	df	p
Pre-test	22	64.68	-3.30	21	.00
Post-test		68.36			

Dependent t-test results in Table 7 show that since it was  $p < .05$ , a significant difference was found between the pre-test and post-test mean scores for the scale for the problem-solving skill of the test group.

### 3.3. Findings Regarding Third Sub-Problem

The third sub-problem of the study is “Is there a statistically significant difference between the pre-test-post-test scores of the scale of problem-solving skills for adults for the control group?”. To understand whether there was a statistically significant difference between the pre-test scores of the scale of problem-solving skills for adults for the test and control groups, the data was analysed using dependent t-test, one of the parametric tests.

**Table 8.** Pre-test-post-test dependent t-test results for the scale of problem-solving skills for adults for the control group.

Test	N	$\bar{X}$	t	df	p
Pre-test	22	66.45	.21	21	.84
Post-test		66			

Dependent t-test results in Table 8 show that since it was  $p > .05$ , no significant difference was found between the pre-test and post-test mean scores for the scale of problem-solving skills for adults for the control group.

### 3.4. Findings Regarding Fourth Sub-Problem

The fourth sub-problem of the study is “Is there a statistically significant difference between the post-test scores of the scale of problem-solving skills for adults for the test and control groups?”. To understand whether there was a statistically significant difference between the post-test scores for the test and control groups, the data was analysed using dependent t-test, one of the parametric tests.

**Table 9.** Post-test independent t-test results for the scale of problem-solving skills for adults for the test and control groups.

Group	N	$\bar{X}$	t	df	p
Test	22	68.36	.91	42	.37
Control	22	66			

Independent t-test results in Table 9 show that since it was  $p > .05$ , no significant difference was found between the post-test mean scores for the scale of problem-solving skills for adults for the test and control groups.

### 3.5. Findings Regarding Fifth Sub-Problem

The fifth sub-problem of the study is “Is there a statistically significant difference between the pre-test scores of the scientific reasoning skills test for the test and control groups?”. To understand whether there was a statistically significant difference between the pre-test scores of the scientific reasoning skills test for the test and control groups, the data was analysed using independent t-test, one of the parametric tests.

**Table 10.** Pre-test independent t-test results for scientific reasoning skills test for the test and control groups.

Group	N	$\bar{X}$	t	df	p
Test	22	12.36	2.81	42	.01
Control	22	9.59			

Independent t-test results in Table 10 show that since it was  $p < .05$ , a significant difference was found between the pre-test mean scores for the scientific reasoning skills test for the test and control groups. Therefore, ANCOVA test was conducted for the post-test mean scores. The findings obtained in ANCOVA test were given in Table 13.

### 3.6. Findings Regarding Sixth Sub-Problem

The sixth sub-problem of the study is “Is there a statistically significant difference between the pre-test-post-test scores of the scientific reasoning skills test for the test group?”. To understand whether there was a statistically significant difference between the pre-test-post-test scores of the scientific reasoning skills test for the test group, the data was analysed using dependent t-test, one of the parametric tests.

**Table 11.** Pre-test-post-test dependent t-test results for the scientific reasoning skills test for the test group.

Test	N	$\bar{X}$	t	df	p
Pre-test	22	12.36	-7.44	21	.00
Post-test		17.09			

Independent t-test results in Table 11 show that since it was  $p < .05$ , a significant difference was found between the pre-test-post-test mean scores for the scientific reasoning skills test for the test group.

### 3.7. Findings Regarding Seventh Sub-Problem

The seventh sub-problem of the study is “Is there a statistically significant difference between the pre-test-post-test scores of the scientific reasoning skills test for the control group?”. To understand whether there was a statistically significant difference between the pre-test-post test scores of the scientific reasoning skills test for the control group, the data was analysed using dependent t-test, one of the parametric tests.

**Table 12.** Pre-test-post-test dependent t-test results for the scientific reasoning skills test for the control group.

Group	Test	N	$\bar{X}$	t	df	p
Control	Pre-test	22	9.59	-8.38	21	.01
	Post-test	22	14.36			

Independent t-test results in Table 12 show that since it was  $p < .05$ , a significant difference was found between the pre-test-post-test mean scores for the scientific reasoning skills test for the control group.

### 3.8. Findings Regarding Eighth Sub-Problem

The eighth sub-problem of the study is “Is there a statistically significant difference between the post-test scores of the scientific reasoning skills test for the test and control groups?”. Upon the revision of the scientific reasoning skills for the pre-test, since it was  $p < .05$ , to understand whether there was a statistically significant difference between the post-test scores of the scientific reasoning skills test for the test and control group, ANCOVA test was applied.

**Table 13.** Post-test ANCOVA test results for the scientific reasoning skills test for the test and control groups.

	Total Squares	df	Mean Squares	F	p
Group	2.53	1	2.53	.33	.57

ANCOVA test results in Table 13 show that  $p = .57$  was found in the post-test data for the scientific reasoning skills test for the test and control group when a common pre-test variable was taken. The results in Table 13 show that since it was  $p > .05$ , no significant difference was found between the post-test mean

scores for the scientific reasoning skills test for the test and control groups.

## 4. Discussion, Conclusion and Recommendations

In the study, as a result of the independent t-test results carried out between pre-test scores of the scale of the problem-solving skills for adults for the test and control groups it was found that the groups were equal. Regarding the pre-test and post-test scores of the scale of problem-solving skills for adults for the test group, a statistically significant difference was found. Problem-solving skills were affected positively at the prospective teachers who were applied verbal intelligence games in the test group. There are some studies supporting this result in the related literature. In a study by Güvenç Çalışkan (2024) it was pointed out that a significant difference was found between the pre-test and post-test scores for the problem-solving skills for the test group which was applied activities developed with verbal games in the unit of force and motion in the science course. Şahin and Tezci (2023) indicated in their studies that there was a significant difference between the pre-test and post-test scores for the problem-solving skills of the test group students playing with intelligence games containing verbal game as well. In a study by Özer (2017), it was pointed out that there was a significant difference between the pre-test and post-test scores for the problem-solving skill of the test group which was applied serious games used for the purpose of education in the science course. In another study by Kurupınar (2021), it was indicated that there was a significant difference between pre-test and post-test scores for the problem-solving skill of the test group for which intelligence game education program including verbal games was developed and to which this program was applied and that intelligence games education program were effective on the problem-solving skills of preschool education children. In a study by Güngör (2021), it was expressed that there was a significant difference between the pre-test and post-test data of the scale aiming at the problem-solving skills of the test group where mental and intelligence games were used and that mental and intelligence games are of effect on the development of problem-solving skills at preschool children. Özen (2023) pointed out in their study that mental and intelligence games affected problem-solving skills positively. It was found in the study that regarding the pre-test and post-test scores of the problem-solving skills scale for adults for control group, there was no statistically significant difference between them. In this sense, it is likely to say that the application of the current science education curriculum in the control group did not affect the problem-solving skills of the prospective teachers statistically. When it comes to the post-test scores for the scale of problem-solving skills for adults for the test and control groups, no statistically significant difference was found between them. Upon the revision of the data, even though the mean score of the test group was higher than that of the control group, this difference

could not be caught statistically. In this context, upon the comparison of the application of current science education undergraduate curriculum (intelligence games course) in the control group with the application of the activities supported with verbal intelligence games in the test group, it was found that problem-solving skills were not affected at a significant level. Because the control group took precedence over the test group regarding the mean score in the pre-test data for the problem-solving skills for adults for the test and control groups, even though test group had a positive improvement, an adequate difference was not formed between the post-tests of the two groups.

In the current study, it was observed that since the groups were not equal at the end of independent t-test result carried out between the pre-test scores for the scientific reasoning skills test for the test and control groups, it was required to conduct ANCOVA test at the post-test. Regarding the pre-test and post-test scores of the scientific reasoning skills test for the test group, it was found that there was a significant difference between them. Scientific reasoning skills were affected positively at the prospective teachers who were applied verbal intelligence games in the test group. When it comes to the pre-test and post-test scores for the scientific reasoning skills test for the control group, it was found that there was a significant difference between them. It was observed that the application of the current science education undergraduate curriculum (intelligence games course) in the control group affected the reasoning skills of the prospective teachers statistically. As for the post-test scores of the scientific reasoning skills test for the test and control groups, it was found that there was no statistically significant difference between them. Because making an application with intelligence games regardless of the sub-dimension both in the test and control groups did not form a similar effect, scientific reasoning skills at the prospective teachers were positively affected. There are some researches supporting the idea of observing a positive effect in scientific reasoning skills with the application of intelligence games in the literature. In their studies, Bottino et al. (2013) indicated that digital intelligence games improved certain reasoning talents. In another study, Kurbal (2015) pointed out that intelligence games course affected reasoning skills positively. In their study, Baki (2022) expressed that game-based mathematics teaching developed reasoning skills at students.

The recommendations developed for the current study are as follows:

1. It was observed that science activities supported with verbal intelligence games affected the problem-solving skills and reasoning skills of the prospective teachers positively. In this sense, it is recommended that verbal intelligence games be used as a significant supportive in teaching different subjects and concepts in the science course.

2. In this study, verbal games, one of the six sub-dimensions of intelligence games, and the other five sub-dimensions were examined within the framework of scientific reasoning skills and problem-solving skills variables. It is likely that some researchers could be carried out with other variables to be able to see other probabilities in the future studies.
3. Verbal intelligence games were integrated into the science course in the research and investigated. It is recommended that similar studies be conducted in different disciplines and the results could be investigated.

## Compliance with Ethical Standards

The research was discussed in the Ethical Commission of Gazi University Rectorship with a date of 09.10.2024 and no of 16 and ethically approved. The date and number of the related documents is 21.10.2024-E.1069674.

## Acknowledgment

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## Conflict of Interest

The authors have no conflict of interest to declare.

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