

The Effect of Simulative Observations in the POE Method on Academic Achievement and Problem Solving Skills of 8th Grade Students

Erkan Çavumirza, Hatice Mertoğlu

Marmara Üniversitesi, İstanbul, Türkiye

Abstract: *Technology is one of the factors affecting students' education. High-level skills, which are described as 21st century skills, are intended to be taught to students who are considered digital natives with the most effective methods. Now, students are expected to develop not only academic success but also high-level skills such as problem solving skills in a course. In this study, the effects of activities developed based on simulative observations in the TGA (Predict-Observe-Explain) method on students' academic success and problem-solving skills were examined in the Algodoo program environment, a technological learning tool. The research was conducted with a quasi-experimental design with a pre-test-post-test control group. The research was conducted with 8th grade students from a state school. Two classes were determined, one control and the other experimental group. In the teaching of the Simple Machines unit, activities based on the in-class TGA method where direct observations could be made were used in the control group, and activities developed based on simulative observations in the TGA method were used in the experimental group. Simple Machines Achievement Test and Problem Solving Skills Scale were used as pre-test and post-test. The collected data were analyzed with the help of the SPSS package program. As a result of the research, it was determined that the academic success of the experimental group, in which activities based on simulative observations were used in the TGA method, was higher than the control group. In addition, it was observed that the development of problem-solving skills in the experimental group was more positive than the control group. It is recommended that the activities*

produced by integrating different technological tools into the TGA method be used in other levels and units in science education and their effectiveness in different skills be investigated.

*Science Insights Education Frontiers 2025; 28(1):4555-4575
DOI: 10.15354/sief.25.or756*

How to Cite: Çavumirza, E., & Mertoğlu, H. (2025). The effect of simulative observations in the POE method on academic achievement and problem solving skills of 8th grade students. Science Insights Education Frontiers, 28(1): 4555-4575.

Keywords: *Academic Success, POE Method, Problem Solving Skills, Simple Machines, Simulation, 8th grade*

About the Authors: Erkan Çavumirza, Marmara University, İstanbul, Türkiye. E-mail: erkancvmrz@gmail.com, ORCID: <https://orcid.org/0000-0001-7688-6723>

Hatice Mertoğlu, Assoc. Prof. Dr. Atatürk Education Faculty, Marmara University, İstanbul, Türkiye. E-mail: hatice.mertoglu@marmara.edu.tr, ORCID: <https://orcid.org/0000-0002-3172-7443>

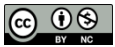
Correspondence to: Erkan Çavumirza at Marmara University in Türkiye.

Conflict of Interests: None

Funding: No funding sources declared.

AI Declaration: The authors affirm that artificial intelligence did not contribute to the process of preparing the work.

© 2025 Insights Publisher. All rights reserved.



Creative Commons NonCommercial CC BY-NC: This article is distributed under the terms of the Creative Commons Attribution-NonCommercial 4.0 License

(<http://www.creativecommons.org/licenses/by-nc/4.0/>) which permits non-commercial use, reproduction and distribution of the work without further permission provided the original work is attributed by the Insights Publisher.

Introduction

HUMANS naturally have a desire to be curious and understand their surroundings. Curiosity is defined as the motivational force that prompts people to conduct research (İnan, 2011). Observation is one of the most effective actions that can be taken to conduct research, gather information and satisfy curiosity. In addition, observation is the most basic of high-level thinking skills. The first action taken to collect data in the face of any problem situation is observation (Eren & Dökme, 2018). Through observation, entities, events and situations are learned and resolved (Çepni & Çil 2012). Observation in science classes is also very important for developing students' scientific thinking and problem-solving skills. Thanks to their observation skills, students can establish relationships between events, establish hypotheses appropriate to the problem situation, collect data and draw scientific conclusions (Luque et al., 2004; Lim, 2006). Observations, which are the first step of scientific methods, provide the opportunity to look at science subjects from different perspectives while also providing active participation in the learning process. In addition, it can be seen as an indispensable action of the constructivist approach to learning models (Lunce, 2006).

By providing students with opportunities to observe, many senses are activated. The multitude of sense organs that students use through observation makes learning more permanent (Ayçiçeği & Oktay, 2013). Technological tools are at the forefront of strategies that enable the use of many sense organs in observation (Alessi & Trollip, 2001). In particular, simulations can provide significant advantages in the classroom when observation and experience are difficult (Heinich, et al., 2002). The purpose of simulations in education is to motivate students to participate in activities such as problem solving, hypothesis testing, experiential learning, and developing mental schemas and models (Winn & Snyder, 1996). Simulations can also be used to facilitate learning to a large extent (Duffy & Cunningham, 1996).

The act of observing, which begins with the birth of a human being, continues throughout life. The ability to observe by eye can also develop with the biological and mental development of a human being (Harlen & Jelly 1989). Therefore, science courses should provide appropriate learning environments for students to use their observation skills and develop this skill (Borich, 2015). The POE method is one of the methods that provide students with the opportunity to make observations in science courses, to discover information and to eliminate misconceptions (Liew & Treagust, 1998). The POE method consists of three basic stages: "Prediction-Observation and Explanation". In the "Prediction" stage, students are asked to make predictions about the event in the activity prepared for them and to

explain their predictions with justifications (Liew & Treagust, 1998). In the “Observation” stage, they are asked to make observations about the events in the activities. One of the important points at this stage is that the student can observe comfortably (Tao & Gunstone, 1999). It is also stated that students recording their observations by writing or drawing will contribute to the effectiveness of the observation (Driver, 1983). Finally, in the “Explanation” stage, students are asked to establish a relationship between the event they observed in the activity and their predictions before the observation, and if there is a contradiction, they are asked to make an explanation that will eliminate this contradiction. Students construct knowledge in their minds during the learning process thanks to the comments they make in the explanation section (Kearney, 2004). They can develop their scientific skills through these three stages. It has been proven that the POE method develops various skills in students, eliminates conceptual misconceptions and thus provides effective learning. It is thought that the application of the POE method in the classroom can develop students’ high-level skills (Palmer, 1995).

In the literature, the POE method has been used in the development of higher-level skills while focusing on students’ academic success and conceptual understanding (Rahayu, Widiyatmoko & Hartono, 2015; Algiranto & Marzuki, 2018; Setiyani, Churiyah & Arief, 2019; Karadeniz, Koçak Altundağ & Yücel, 2020; Sarah, Khanif & Saputra, 2021; Bostan Sarioğlan & Sarıca, 2023; Uriyah, Supardi & Suryanti, 2023; Safitri, Agnafia & Anfa, 2024). In addition, it is seen that research on improving students’ problem-solving skills with the POE method is continuing (Yenice, Alpak Tunç & Candarlı, 2019; Fitriani, Zubaidah, Susilo & Al Muhdhar, 2019). In this context, the Prediction-Observation-Explanation (PEA) method is seen as an important alternative for improving students’ access to scientific knowledge and problem-solving skills (White & Gunstone, 1992; Kearney & Treagust, 2001; Tekin, 2006; Çimer & Çakır, 2008).

In the current era, the rapid increase in the amount of information and the need to enrich the learning environment have made it necessary to use technological tools and programs in education (Ingram & Jackson, 2004). Simulations come first among technological tools and programs. Education supported by simulations enriches the learning environment with experiences in a virtual environment for students (Chernikova et al., 2020). Simulation-supported education is the imitation of real-life computer programs or special technological tools. With simulations, they can conduct tests and experiments without being in dangerous environments and without getting hurt (Kalemkuş & Kalemkuş, 2023). In this way, students can gain experience by practicing in conditions similar to the situations they will encounter in real life (Güvercin, 2010). In addition, inadequacy of science laboratories in schools, ineffectiveness of laboratory methods in case of

crowded classes or reluctance of teachers in this regard may make simulation activities mandatory (Gredler, 2004). Simulations can be used to encourage student-centered learning and to prepare for situations that may be encountered in real life (Banda & Nzabahimana, 2023). One of the simulation programs that offer high-level interaction and virtual experience opportunities, especially for educational purposes, is the Algodoo program. It is an easy simulation tool that is used to simulate many physical scenarios and can be easily used by students (Cayvaz & Akcay, 2018). Algodoo is a freely accessible two-dimensional physics-based virtual space software. It has an interface that allows users to interact in a virtual environment, create objects and conduct virtual experiments close to reality (Gregorcic, 2015).

In the literature, technological tools have been intensively examined at the 6th and 7th grade levels and their effects on academic success (Arduç, 2024). However, in Turkey, students can be placed in high schools according to their academic success in the High School Entrance Exam, which is a central exam at the end of the 8th grade (Bayar & Gürlek, 2022). A study to be conducted at the 8th grade level can make a more meaningful contribution to both their problem-solving skills and academic success. It is thought that further studies on this subject and examining the factors affecting the academic success and problem-solving skills of different student groups will also contribute to the literature. In this study, it was aimed to examine the effects of using activities supported by simulative observations in the Algodoo environment in the POE method in the teaching of the Simple Machines unit on the academic success and problem-solving skills of 8th grade students.

Problem Statement

Do activities based on simulative observations in the POE method have an effect on students' academic success and problem-solving skills in the simple machine's unit?

Sub-Problem Statements

- *What is the effect of activities based on simulative observations in the POE method on the academic success of 8th grade students in the simple machine's unit?*
- *What is the effect of activities based on simulative observations in the POE method on the problem-solving skills of 8th grade students in the simple machine's unit?*

Table 1. Practices Regarding the Working Group.

Group	Pre test	Experimental Application	Pro test
Control	Simple Machines Unit Achievement Test (SMUA)	Observations on the Model in POE Method	Simple Machines Unit Achievement Test (SMUA)
Experimental	Problem Solving Skills Scale (PSS)	Simulative Observations in the POE Method	Problem Solving Skills Scale (PSS)

Method

Designs that aim to find the cause-effect relationship between variables are called experimental designs (Büyüköztürk, 2007). In this research, in order to find the cause-effect relationship of the experimental operations conducted on the variables of academic success and problem solving skills in the activities based on simulative observations in the POE method, a pre-test post-test control group quasi-experimental design was used. In the research, the same pre-tests and post-tests were applied to the experimental and control groups in the teaching of the Simple Machines unit. The lessons were processed in parallel in the experimental and control groups. In the experimental group, lessons were conducted with activities based on simulative observations integrated with the TGA method. In the control group, the activities were conducted with the TGA method, in which observations were made on models brought into the classroom environment.


Study Group

The sample of the study consists of eighth grade students of a state middle school in the city center of Sakarya. It was conducted with a total of 61 students, one of two classes being the control group (31) and the other being the experimental group (30). The classes were formed by the school administration according to their academic achievements. It was determined that the study group students did not know the POE method and simulative observations and did not benefit from any other course with this method (Table 1).

Application

In order to measure the effect of activities based on simulative observations in the POE method on academic success and problem-solving skills in students, two classes from the 8th grades, which were stated to be created at an equal level by the school administration, were selected. The application was carried out for 8 weeks in the 2023-2024 academic year. In the experimental group, 6 previously prepared POE method-based activity worksheets were prepared for teaching the Simple Machines unit. Students

ACTIVITY-1: HOW SHOULD I USE LEVERAGE?
 Fatih wants to roll a piece of rock to the edge of his field. Fatih tries to push it with his own hands but cannot lift it. In order to lift the rock, he wants to use a sturdy plank and a piece of stone to support it from below.



PREDICTION: Fatih put the end of the board under the rock and wants to move the rock with a little force.

1- Under which of the points A, B, C, D, E, F and G should the support stone be placed? Write your predictions and show with a drawing.

2- At which of the points A, B, C, D, E, F and G should Fatih apply force? Show your best guesses by drawing them.

OBSERVATION: You can observe the answers you guessed by drawing them in the Algodoo program and using simulation studies. Determine the most suitable position of the plank and support stone by using simulation studies. Try to test all your predictions.

EXPLANATION: In order for Fatih to lift the rock with little force,

1- Were you able to try all your guesses? Which predictions did you fail?

2- Where is the most appropriate point of the support stone to lift the rock? Explain why.

3- Where must Fatih apply the least force to the plank to lift the rock? Explain why.

4- According to your estimates and observations, draw the most suitable shape of the support stone and plank to lift the rock with a small force.

Figure 1. Simulative Double-Sided Leverage POE Efficiency.

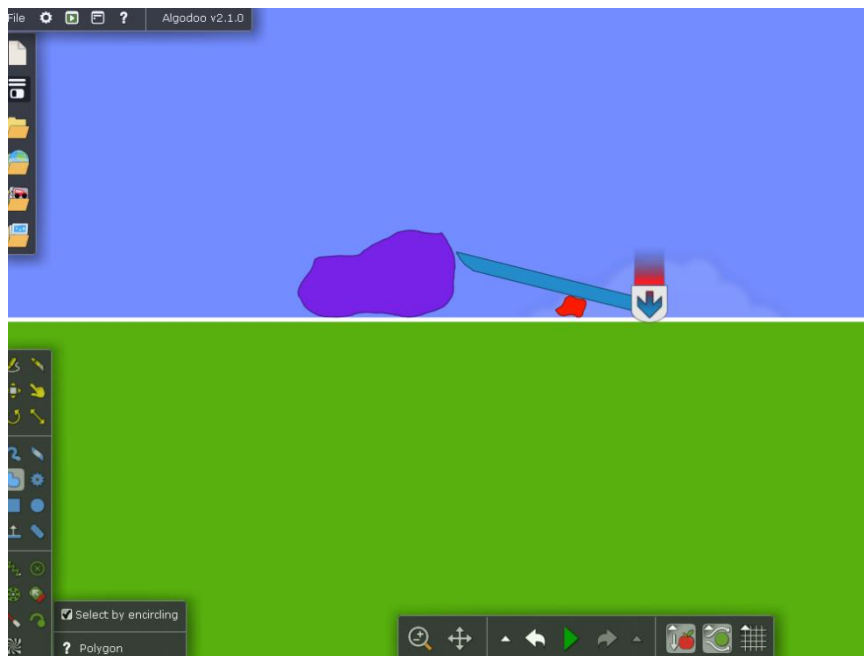


Figure 2. Double-Sided Leverage Simulation Study in Algodoo Program.

used simulation activities prepared in the Algodoo program for the observation phase of the POE method. The simulation was carried out in the computer class where each student was given a computer to do the activities easily. First of all, students were asked to write their predictions appropriate to the problem situation in each activity in accordance with the POE model. An example POE method-based activity based on simulative observations in the research is given in **Figure 1**.

After the prediction phase was completed, they completed their observations by conducting simulation studies with the Algodoo program for the activities related to the subject. Students were provided with the opportunity to discuss their observations in the Algodoo program. Students were asked to compare their predictions appropriate to the problem situation and their simulative observations and establish a relationship between their predictions before the observation. An example of the Algodoo simulation study used in the research is given in **Figure 2**.

If there was a contradiction between the prediction and the simulative observation, they were asked to write the explanations that would eliminate this contradiction in the explanation section of the worksheet.

In the control group, the Simple Machines unit used 6 previously prepared POE method-based activity worksheets. The students were asked to write their predictions appropriate to the problem situation in the activity on the worksheets. An example POE method activity based on observations on the model in the study is given in **Figure 3**.

Unlike the experimental group, the students in the control group made their observations by trying them on the models. After the prediction phase was completed, they completed their observations on the subject on the models brought to the classroom environment. The students were asked to compare their predictions and observations and establish a relationship between their predictions before the observation. An example of the observation studies conducted on the model in the classroom is given in **Figure 4**.


If there was a contradiction between the prediction and the observation, they were asked to write their own explanations that would eliminate this contradiction in the explanation section of the worksheet. Data collection tools were applied to both groups, pre-test and post-test before and after the experimental process.

Data Collection Tools

- *Simple Machines Unit Achievement Test (SMUA)*: The “Simple Machines Unit Achievement Test” developed by Özkan & Eryılmaz Muştu (2008) was applied to determine the academic success of students in the Simple Machines unit. Özkan & Eryılmaz Muştu (2018)

ACTIVITY-1 HOW SHOULD I USE THE WHEELBARROW?

Mehmet wants to carry a bag of cargo with a wheelbarrow. Mehmet wants to carry the cargo comfortably by applying less force to the wheelbarrow than the weight of the cargo. For this reason, he cannot decide where to place the load on the trough of the wheelbarrow and from which point of the wheelbarrow he will hold it.




PREDICTION: In order for Mehmet to carry the load with little force,

1- Where should he place the load on the cart's bottom (A, B, C)? Write your predictions. Write your predictions and show with a drawing.

2- At which point (X, Y, Z) should Mehmet hold the wheelbarrow? Write your predictions. Write your predictions and show with a drawing.

OBSERVATION: Make observations by doing activities related to the use of the wheelbarrow.



1- Based on your observations, determine the most suitable spot for the load on the wheelbarrow boat.

2- Based on your observations, determine the most appropriate holding point for the wheelbarrow.

EXPLANATION: By comparing your predictions and observations for Mehmet to be able to carry the load with a small force, Which of your predictions did you find successful or unsuccessful regarding the points of application of the load and force? As a result of your predictions and observations, show the most suitable mode of transportation with a drawing.

2- Where is the most suitable point for the load (A, B, C)? Explain why.

3- Where is the most suitable place for Mehmet to hold (X, Y, Z)? Explain why.

As a result of your predictions and observations, show the most suitable mode of transportation with a drawing.

Figure 3. Unilateral Leverage POE Efficiency.



Figure 4. Single-Sided Lever Study on the Model

developed the 19-question Simple Machines Unit Achievement Test (SMUA) in their study titled “Development of Achievement Test for the 8th Grade Simple Machines Unit: Validity and Reliability”. The reliability coefficient (Cronbach alpha) of the test was calculated as 0.88. As a result of the analysis, it was stated that the Simple Machines Unit Achievement Test (SMUA) was a valid and reliable measurement tool. In this study, the reliability coefficient (Cronbach alpha) was measured as 0.82.

- *Problem Solving Skills Scale (PSS)*: In order to determine the problem-solving skills of the students, the “Problem Solving Skills Scale” developed by Ge & Land (2003) and translated into Turkish by Coşkun (2004) was applied. The specified scale includes a total of four main items, each belonging to a problem level, and five sentences that can be answered for each item. Each sentence can be answered as “Always”, “Frequently”, “Sometimes”, “Very rarely”, “Never”. The answers are scored and graded with values ranging from 1 to 5. The scale includes a total of 20 sentences in 4 problem levels. The first five items are related to the interpretation and problem definition stage, items 6 to 10 are related to the stage of developing solutions and monitoring the solution process, and items 11 to 15 are related to the stage of decision making and evaluating the problem-solving process. Items 16-20 consist of items related to specific strategies used in problem solving. In this study, the reliability coefficient (Cronbach alpha) of the Problem-Solving Skills Scale was determined as 0.83.

Data Analysis

The data obtained from the applied tests were analyzed with SPSS 22 program. Since the data obtained from the achievement test showed normal distribution, parametric tests were conducted. In order to understand whether there was a significant difference between the control and experimental groups in the pre-test and post-test in the achievement test, an independent groups t-test was conducted. A dependent t-test was conducted between the pre-test and post-test within the groups.

Since the data obtained from the problem-solving skill scale did not show normal distribution, non-parametric tests were conducted. In order to understand whether there was a significant difference between the control and experimental data in the pre-test and post-tests obtained from the problem-solving skill scale, a Mann-Whitney U test was conducted. In order to understand whether there was a significant difference between the control and experimental data in the pre-test and post-test within the groups, a Wilcoxon Signed Rank Test was conducted.

Table 2. Independent Groups T-Test Results Regarding Pre-Test Scores of Simple Machines Unit Achievement Test of Control and Experimental Groups.

Group	N	Mean	ss	t	Sd	P
Control	31	3.67	1.13	0.386	59	0.701
Experimental	30	3.56	1.10			

Table 3. Dependent Groups T-Test Results Regarding Pre-Test-Post-Test Scores of Control Group Students' Simple Machines Achievement Test.

Tests	N	Mean	ss	t	Sd	P
Pre-test	31	31	1.13	-22.71	30	0.00
Post-test	31	31	2.10			

Findings

In this section, the research findings are presented in the form of comments and tables according to sub-problems.

The Effect of Activities Based on Simulative Observations in the POE Method on Students' Academic Success

The data regarding the pre-test and post-test of the study groups regarding the question “What is the effect of activities based on simulative observations in the POE method on the academic success of 8th grade students in the subject of simple machines?” which is the first sub-problem sentence of the research were analyzed.

The independent groups t-test analysis results regarding the scores obtained from the Simple Machines Unit Achievement Test applied as a pre-test to the control and experimental groups are given in **Table 2**.

According to the analysis results given in **Table 2**, no statistically significant difference was found between the scores of the control group and the experimental group in the pre-test Simple Machines Unit Achievement Test ($p > 0.05$).

The dependent groups t-test analysis results regarding the scores of the control group in the Simple Machines Achievement Test applied as pre-test and post-test are given in **Table 3**.

Table 4. Dependent Groups t-Test Results Regarding Pre-Test-Post-Test Scores of Experimental Group Students' Simple Machines Achievement Test.

Test	N	Mean	ss	t	Sd	P
Pre-test	30	3.56	1.10	-21.55	29	0.00
Post-test	30	16.20	2.72			

Table 5. Independent Groups t-Test Results Regarding Simple Machines Achievement Test Post-Test Scores of Control and Experimental Groups.

Group	N	Mean	ss	t	Sd	P
Control Group	31	13.61	2.10	-4.158	59	0.00
Experimental Group	30	16.20	2.72			

According to the analysis results given in **Table 3**, a statistically significant difference was found between the scores of the control group in the pre-test and post-test Simple Machines Unit Achievement Test ($p < 0.05$). According to the results of this analysis, it can be said that activities based on the POE method, where direct observations are made, are effective in learning the course outcomes.

The dependent groups t-test analysis results regarding the scores of the experimental group in the Simple Machines Unit Achievement Test, which was applied as a pre-test and post-test, are given in **Table 4**.

According to the analysis results given in **Table 4**, a statistically significant difference was found between the scores of the experimental group from the pre-test and post-test Simple Machines Unit Achievement Test ($p < 0.05$). According to the results of this analysis, it can be said that the activities carried out based on simulative observations in the POE method were effective in learning the course outcomes.

The independent groups t-test analysis results regarding the scores of the Simple Machines Achievement Test applied to the control and experimental groups as a post-test are given in **Table 5**.

According to the analysis results given in **Table 5**, a statistically significant difference was found between the scores of the control group and the experimental group in the post-test Simple Machines Unit Achievement Test ($p < 0.05$). According to the results of this analysis, it can be said that the activities carried out based on simulative observations in the POE method positively affected the experimental group and were more effective in learning the course outcomes.

Table 6. Mann Whitney U Test Results Regarding Pre-Test Scores of Problem Solving Skills Scale of Experimental and Control Groups.

Dimensions	Group	N	Avg. Rank	Total Rank	U	P
Before You Start Solving Problems	Control	31	27.39	849.00	353.00	0.101
	Experimental	30	34.73	1042.00		
Working on the Problem	Control	31	29.94	928.00	432.00	0.629
	Experimental	30	32.10	963.00		
After You Finish Working on the Problem	Control	31	28.98	897.50	401.50	0.353
	Experimental	30	33.12	993.50		
Which Method is Applied to the Problem	Control	31	29.92	927.50	431.50	0.625
	Experimental	30	32.112	963.50		

The Effect of Activities Based on Simulative Observations in the POE Method on Students' Problem-Solving Skills

The data regarding the pre-test and post-test of the study groups regarding the question “What is the effect of activities based on simulative observations in the POE method on the problem-solving skills of 8th grade students?” which is the second sub-problem statement of the research were analyzed.

The scores obtained from the Problem Solving Skills Scale applied as a pre-test to the control and experimental groups were compared using the Mann-Whitney U Test and the analysis results are given in **Table 6**.

According to the analysis results given in **Table 6**, no statistically significant difference was found in all sub-dimensions of the Problem-Solving Skills Scale between the control group and the experimental group before the experimental procedure ($p > 0.05$). It can be said that there was no difference in problem solving skills between the control group and the experimental group before the experimental procedure.

The scores obtained from the Problem Solving Skills Scale applied to the control group as pre-test and post-test were compared using the Wilcoxon Signed Ranks Test and the analysis results are given in **Table 7**.

According to the analysis results given in **Table 7**, a statistically significant difference was found between the scores of the control group in all sub-dimensions of the pre-test and post-test Problem Solving Skills Scale ($p < 0.05$). According to the results of this analysis, it can be said that the activities based on the POE method, where direct observations were made,

Table 7. Wilcoxon Signed Rank Test Results Regarding the Pre-Test and Post-Test Scores of the Problem Solving Skills Scale of the Control Group Students.

Dimensions	Pre-Test Post-Test	N	Avg. Rank	Total Rank	z	P
Before You Start Solving Problems	Negative Rank		0.00	0.00	-4.878	0.00
	Positive Rank	31	16.00	496.00		
	Equal					
Working on the Problem	Negative Rank		0.00	0.00	-4.873	0.00
	Positive Rank	31	16.00	496.00		
	Equal					
After You Finish Working on the Problem	Negative Rank		0.00	0.00	-4.866	0.00
	Positive Rank	31	16.00	496.00		
	Equal					
Which Method is Applied to the Problem	Negative Rank		0.00	0.00	-4.866	0.00
	Positive Rank	31	16.00	496.00		
	Equal					

Table 8. Wilcoxon Signed Rank Test Results Regarding the Pre-Test and Post-Test Scores of the Problem Solving Skills Scale of the Experimental Group Students.

Dimensions	Pre-Test Post-Test	N	Avg. Rank	Total Rank	z	P
Before You Start Solving Problems	Negative Rank		0.00	0.00	-4.799	0.00
	Positive Rank	30	15.50	465.00		
	Equal					
Working on the Problem	Negative Rank		0.00	0.00	-4.792	0.00
	Positive Rank	30	15.50	465.00		
	Equal					
After You Finish Working on the Problem	Negative Rank		0.00	0.00	-4.793	0.00
	Positive Rank	30	15.50	465.00		
	Equal					
Which Method is Applied to the Problem	Negative Rank		0.00	0.00	-4.790	0.00
	Positive Rank	30	15.50	465.00		
	Equal					

were effective in the development of problem solving skills of the control group students.

The scores of the Problem Solving Skills Scale applied to the experimental group as pre-test and post-test were compared using the Wilcoxon Signed Ranks Test and the analysis results are given in **Table 8**.

Table 9. Mann Whitney U Test Results Regarding the Post-Test Scores of the Problem Solving Skills Scale of the Experimental and Control Groups.

Dimensions	Group	N	Avg. Rank	Total Rank	U	P
Before You Start Solving Problems	Control	31	19.87	616.00	120.00	0.00
	Experimental	30	42.50	1275.00		
Working on the Problem	Control	31	17.39	539.00	43.00	0.00
	Experimental	30	45.07	1352.00		
After You Finish Working on the Problem	Control	31	17.26	535.00	39.00	0.00
	Experimental	30	45.20	1356.00		
Which Method is Applied to the Problem	Control	31	18.02	558.50	62.50	0.00
	Experimental	30	44.42	1332.50		

According to the analysis results given in **Table 8**, a statistically significant difference was found between the scores of the experimental group in all sub-dimensions of the pre-test and post-test Problem Solving Skills Scale ($p < 0.05$). According to the results of this analysis, it can be said that the activities based on simulative observations in the POE method were effective in the development of problem solving skills of the experimental group students.

The scores obtained from the Problem Solving Skills Scale, which was applied as a post-test to the control and experimental groups, were compared using the Mann-Whitney U Test and the analysis results are given in **Table 9**.

According to the analysis results given in **Table 9**, a statistically significant difference was found in all sub-dimensions of the Problem-Solving Skills Scale between the control group and the experimental group after the experimental procedure ($p < 0.05$). According to the results of this analysis, it can be said that the activities carried out based on simulative observations in the POE method were more effective in the development of problem solving skills of the students in the experimental group.

Results and Discussion

This study aimed to investigate the effects of activities based on simulative observations in the POE method on the academic success and problem-solving skills of 8th grade students in the teaching of the “Simple Machines” unit. According to the analysis results, it is seen that both the POE method, in which observations are made on models in the classroom environment, and the POE method, in which simulative observations are made through the Algodoo program, are effective on the academic success of the students in the teaching of the “Simple Machines” unit. It can be said that the POE

activities carried out in both groups provide effective learning and the students' academic success is carried to better levels. There are studies in the literature where science teaching using models has a positive effect on increasing student success (Taylor, Barker & Jones, 2003; Bilal, 2010; Demirhan, 2015; Zorlu, 2016; Çavumirza, 2018; Demirçalı, & Selvi, 2022). It has been determined that observations made using models are functional in making the knowledge more permanent in students. It is thought that models brought into the classroom environment provide students with learning richness and increase interest in science learning, as well as activating many sense organs (Jackson, Dukerich, & Hestenes, 2008). Studies in the literature also support the results of this research. In addition, studies in the literature have found that simulation-supported activities have a positive effect on students' academic success (Dağdalan & Taş, 2017; Kim & Kim, 2018; Cayvaz & Akcay, 2018; Kirmizigül, 2021; Keskin, 2022; Karahan, 2022). The studies examined have proven that simulation-based teaching methods in science education have high potential effects on academic success (Rutten, van Joolingen & van der Veen, 2012). The effects of simulative studies in science education in the literature are also parallel to the results of this research.

It has been determined that there is not enough research in the literature to determine which of the observations on models and simulative observations are more effective. Some studies have proven that simulation-supported science teaching is more effective than observations on models in academic achievement and recall (Sertkaya, 2018; Minashi, 2009). It is thought that the integration of technology-based educational tools into today's educational approach for students who grow up intertwined with technology will enable them to participate more effectively in the learning process. According to the findings, it can be said that the integration of the Algodoo program, which is a technological simulation tool, into the POE method, especially the simulation studies in the observation phase, make students cognitively active and increase their academic success thanks to a large number of experiences.

According to the analysis results of the data obtained from the Problem Solving Skills Scale applied to the students before the experimental procedure, it is seen that the control group and the experimental group are at the same level in terms of problem solving skills. It is observed that there is a positive difference in all dimensions of problem solving skills of both the control and experimental groups after the experimental procedure. This shows that the activities carried out based on simulative observations in the TGA method positively affect the problem solving skills of the students. This result is consistent with other studies showing that lessons in which simulation techniques are carried out contribute to the development of problem solving skills (Geban, Askar & Özkan, 1992; Son & Song, 2012;

Simanjuntak, Hutahaean, Marpaung& Ramadhani, 2021; Liana, Kosim & Taufik, 2023). In addition, there are studies in the literature that determine that science teaching using models increases students' problem-solving skills (Malone, 2006); Demirhan2015;). However, it is seen that the effect of activities based on simulative observations in the TGA method on problem solving skills is more effective than TGA activities where observations are made on models. It can be said that the simulation activities carried out in the Algodoo program contribute more to the development of students' problem-solving skills with the opportunities to do experiments and observations many times and to try alternative activities with different designs. Computer simulations are seen as effective tools in developing students' skills such as forming hypotheses and making predictions with the trial and error and retry opportunities they offer to students (Şahin, 2006). Any activity used in science education can be effective in students' learning the outcomes of that course. However, it can be said that integrating simulation techniques into the POE method, which makes students active in the learning process and enables the concepts to be structured in their minds, provides both academic success and the development of high-level thinking skills such as problem solving skills. When determining teaching methods, it is essential to choose teaching method techniques that will not only improve students' academic success but also enable the development of many skills.

Recommendations

It is recommended that other technological tools that are thought to contribute to the development of 21st century skills be examined on students.

Reference

- Alessi S. M. & Trollip, S.R. (2001). Multimedia for learning: Methods and development. (254-257). Boston: Allyn & Bacon. United States
- Algiranto, Sarwanto & Marzuki, A. (2019, February). The development of students worksheet based on Predict, Observe, Explain (POE) to improve students' science process skill in SMA Muhammadiyah Imogiri. In Journal of Physics: Conference Series, 1153(1), 1-6. DOI: <https://doi.org/10.1088/17426596/1153/1/012148>
- Ardu ç M. A. (2024). Teknoloji Destekli Fen Bilimleri Eğitimi Çalışmalarının İncelenmesi (2020-2023): İçerik Analizi. Alanyazın, 5(1), 85-103. <https://doi.org/10.59320/alanyazin.1422735>
- Ayçiçeği, A., & Oktay, A. (2013). İlkokul ve Ortaokul Ders Kitaplarının Fiziksel Özelliklerinin İncelenmesi. Marmara Üniversitesi Atatürk Eğitim Fakültesi

- Eğitim Bilimleri Dergisi, 8(8), 33-40.
<https://dergipark.org.tr/pub/maruabed/issue/363/2025>
- Banda, H. J., & Nzabahimana, J. (2023). The impact of physics education technology (PhET) interactive simulation-based learning on motivation and academic achievement among malawian physics students. *Journal of Science Education and Technology*, 32(1), 127-141.
<https://doi.org/10.1007/s10956-022-10010-3>
- Bayar, A., & Gürlek, M. (2022). Ortaokul Öğretmenlerine Göre 8. Sınıf Öğrencilerin Liseye Geçiş Sınavıyla İlgili Yaşadıkları Sorunlar ve Bu Sorunlara İlişkin Çözüm Önerileri. *Ulusal Eğitim Akademisi Dergisi*, 6(2), 215-229. DOI:
<https://doi.org/10.32960/uead.1165193>
- Borich, G.D. (2015). *Observation Skills for Effective Teaching: Research-Based Practice* (7th ed.). Routledge.
<https://doi.org/10.4324/9781315633206>
- Bostan Sarioğlan, A., & Sarıca, E. (2023). TGA Destekli Sorgulama Temelli Öğretimin Akademik Başarıya ve Bilimsel Sorgulama Becerisine Etkisi. *Bahkesir Üniversitesi Fen Bilimleri Enstitüsü Dergisi*, 25(1), 279-292. DOI:
<https://doi.org/10.25092/baunfbed.1180304>
- Büyükoztürk, Ş. (2007). *Deneysel Desenler: Öntest-Sontest Kontrol Grubu Desen ve Veri Analizi*. Pegem A Yayıncılık, Ankara.
- Cayvaz, A., & Akcay, H. (2018). The Effects of using Algodoo in Science Teaching at Middle School. *The Eurasia Proceedings of Educational and Social Sciences*, 9, 151-156.
<https://dergipark.org.tr/en/download/article-file/531768>
- Chemikova, O., Heitzmann, N., Stadler, M., Holzberger, D., Seidel, T., & Fischer, F. (2020). Simulation-based learning in higher education: a meta-analysis. *Review of Educational Research*, 90(4), 499-541. DOI:
<https://doi.org/10.3102/0034654320933544>
- Coşkun, M. (2004). Coğrafya Öğretiminde Proje Yaklaşımı. *Ahi Evran Üniversitesi Kırşehir Eğitim Fakültesi Dergisi*, 5(2), 99-107.
<https://dergipark.org.tr/pub/kefad/issue/57226/808286>
- Çavumirza, E. (2018). Model ile Fen Öğretiminin 8. Sınıf Öğrencilerinin Başarılarına, Eleştirel Düşünme Eğilimlerine, Tutumlarına ve Kavram Öğrenmelerine Etkisi [Master's Thesis], Sakarya University, Sakarya.
- Çepni, S. & Çil, E. (2012). *Fen ve teknoloji programı ilköğretim 1. ve 2. kademe öğretmen el kitabı*. Ankara: Pegem A
- Dağdalan, G., & Taş, E. (2017). Simülasyon Destekli Fen Öğretiminin Öğrencilerin Başarısına ve Bilgisayar Destekli Fen Öğretimine Yönelik Tutumlarına Etkisi. *Fen Bilimleri Öğretimi Dergisi*, 5(2), 160-172.
<https://dergipark.org.tr/pub/fbod/issue/71996/1158045>
- Demirhan E. (2015). 3D Model Tasarlamının Fen Bilgisi Öğretmen Adaylarının Akademik Başarıları, Problem Çözme Becerileri, Bilimsel Yaratıcılıkları ve Sürece Yönelik Algılarına Etkisinin İncelenmesi. [Master's Thesis]. Marmara University, İstanbul.
- Demirçalı, S. & Selvi, M. (2022). Model tabanlı fen eğitiminin öğrencilerin akademik başarıları ve bilimsel süreç becerileri üzerindeki etkileri: Araştırma Makalesi. *Türk Fen Eğitimi Dergisi*, 19 (2), 545-558. <https://doi.org/10.36681>
- Driver, R., 1983. *The Pupil As Scientist?*, Open University Press, London.
- Duffy, T. & Cunningham, D. (1996). *Constructivism: Implications for the Design and Delivery of Instruction.*, Handbook of research on educational communications and technology. New York: Simon & Schuster.
- Eren, E. & Dökme, İ. (2018). Fen Bilgisi Öğretmen Adaylarının Gözlem Yapabilme Becerilerinin Değerlendirilmesi, Eğitimde güncel araştırmalar, 651-671. Cetinje.
- Fitriani, A., Zubaidah, S., Susilo, H., & Al Muhdhar, M. H. I. (2019). The Integrated Problem Based Learning and Predict, Observe, Explain (PBL-POE) to Empower Students' Problem-Solving Skills. *Proceedings of the 2019 3rd International Conference on Education and Multimedia Technology - ICEMT 2019*. DOI:
<https://doi.org/10.1145/3345120.3345139>
- Ge, X., & Land, S. M. (2003). Scaffolding students' problem-solving processes in an III-structured task using question prompts and peer interactions. *Educational Technology Research and Development*, 51(1), 21-38. DOI:
<https://doi.org/10.1007/bf02504515>

- Geban, Ö., Askar, P., & Özkan, İ (1992). Effects of Computer Simulations and Problem-Solving Approaches on High School Students. *The Journal of Educational Research*, 86(1), 5-10. DOI: <https://doi.org/10.1080/00220671.1992.9941821>
- Gredler, M. E. (2004). Games and Simulations and Their Relationships to Learning. *Handbook of research on educational communications and technology*, 571-581. Lawrence Erlbaum Associates Publishers.
- Gregorcic, B. (2015). Exploring Kepler's laws using an interactive whiteboard and Algodoo. *Physics Education*, 50(5), 511-515. DOI: <http://iopscience.iop.org/0031-9120/50/5/511>
- Güvercin, Z. (2010). Fizik dersinde simülasyon destekli yazılımın öğrencilerin akademik başarısına, tutumlarına ve kalıcılığa etkisi. [Master's Thesis]. Çukurova University, Adana.
- Harlen, W. & Jelly, S. (1989) Developing science in the primary classroom. London.
- Heinich, S., Molenda, J., Russel, R. & Smaldino M., (2002). *Instructional media and technologies for learning*, 7th ed., Pearson Education, New Jersey
- Ingram, K. W. & Jackson, M. K. (2004). Simulations as authentic learning strategies: Bridging the gap between theory and practice in performance technology. In *Association for Educational Communication and Technology (AECT)*, 297-307. <https://files.eric.ed.gov/fulltext/ED485146.pdf>
- İnan, I. (2011). *The Philosophy of Curiosity* (1st ed.). Routledge. DOI: <https://doi.org/10.4324/9780203128893>
- Jackson, J., Dukerich, L. ve Hestenes, D. (2008). Modeling Instruction: An Effective Model for Science Education. *Science Educator*, 17(1), 10-17.
- Koreš, J. (2012). Using Phun to Study "Perpetual Motion" Machines. *The Physics Teacher*, 50(5), 278-279. DOI: <https://doi.org/10.1119/1.3703542>
- Kalemkuş, F., & Kalemkuş, J. (2023). Fen eğitiminde güncel dijital teknolojiler. *Matematik ve Fen Bilimleri Eğitiminde Yeni Yaklaşımlar 2023*, 143, İstanbul.
- Karadeniz, A., Koçak Altındağ, C., & Yücel, S. (2020). Tahmin Et - Gözle - Açıkla Yöntemi Destekli Etkinliklerin Lise Öğrencilerinin Üst Biliş Farkındalıklarına Etkisinin Araştırılması. *Abant İzzet Baysal Üniversitesi Eğitim Fakültesi Dergisi*, 20(4), 1881-1898. DOI: <https://doi.org/10.17240/aiuefd.2020.20.58249-648859>
- Karahan, M. (2022). Simülasyon destekli fen öğretiminin 6. sınıf öğrencilerinin akademik başarısına etkisi/vücudumuzda ki sistemler ünitesi. [Master's Thesis]. Akdeniz University, Antalya.
- Kearney, M., 2004. Classroom Use of Multimedia-Supported Predict-Observe-Explain Tasks in a Social Constructivist Learning Environment, *Research in Science Education*, 34, 427-453. DOI: <http://dx.doi.org/10.1007/s11165-004-8795-y>
- Kearney M. & Treagust, D. F. (2001). Constructivism as a referent in the design and development of a computer program using interactive digital video to enhance learning in physics. *Australian Journal of Educational Technology*, 17(1), 64-79. DOI: <https://doi.org/10.14742/ajet.1773>
- Keskin, Z. (2022). Fen bilimleri öğretmenleri ve 7. sınıf öğrencilerinin etkileşimli simülasyon deneyimlerinin incelenmesi. [Master's Thesis]. Kırşehir Ahi Evran University, Kırşehir.
- Kim, J. S., & Kim, J. B. (2018). The Changes of Analogies Generated by Elementary Science-gifted Students about Electric Circuit using Algodoo Program. *Journal of Korean Elementary Science Education*, 37(2), 161-172. DOI: <https://doi.org/10.15267/KESES.2018.37.2.161>
- Kirmizigül, A. S. (2021). Algodoo for Interactive Learning: Effects on Students' Achievement and Motivation Towards Science. *Shanlax International Journal of Education*, 9(4), 352-58. DOI: <https://doi.org/10.34293/education.v9i4.4195>
- Liana, L., Kosim, K., & Taufik, M. (2023). The Influence of the Problem-Based Learning Model Assisted by PhET Simulations on Students' Problem-Solving Abilities and Mastery of Physics Concepts. *AMPLITUDO Journal of Science and Technology Innovation*, 2(2), 101-107. DOI: <https://doi.org/10.56566/amplitudo.v2i2.103>
- Liew, C W ve Treagust, D F., (1998). The Effectiveness of Predict- Observe-Explain Tasks in Diagnosing Students' Understanding of Science and in Identifying Their Levels of Achievement, *Annual Meeting of the American*

- Educational Research Association, 13-17, San Diego.
<https://files.eric.ed.gov/fulltext/ED420715.pdf>
- Lim, K. F. (2006). Use of spreadsheet simulations in university chemistry education. *Journal of Computer Chemistry*, 5(3), 139-146.
<https://files.eric.ed.gov/fulltext/ED497495.pdf>
- Luque, E. G., Ortega, T., Forja, J. M., & Parra, A. G. (2004). Using a laboratory simulator in the teaching and study of chemical processes in estuarine systems. *Computers & Education*, 43, 81-90.
<https://eric.ed.gov/?id=EJ739241>
- Lunce, L. M. (2006). Simulations: Bringing the benefits of situated learning to the traditional classroom. *Journal of Applied Educational Technology*, 3(1), 37-45.
https://lisastarks.synthasite.com/resources/JAET3-1_Lunce.pdf
- Malone, K. L. (2006). A Comparative Study of the Cognitive and Meta Cognitive Differences Between Modeling and Non-Modeling High School Physics Students. [Unpublished master's thesis], Carnegie Mellon University, Pittsburgh.
- Minaslı, E. (2009). Fen ve teknoloji dersi maddenin yapısı ve özellikleri ünitesinin öğretilmesinde simülasyon ve model kullanılmasının başarıya, kavram öğrenmeye ve hatırlamaya etkisi. [Unpublished master's thesis], Marmara University, İstanbul.
- Özkan, E. B. & Eryılmaz Muştu, Ö. (2018). 8. Sınıf Basit Makineler Ünitesine Yönelik Başarı Testi Geliştirme: Geçerlik Ve Güvenirlik Çalışması . Hitit Üniversitesi Sosyal Bilimler Enstitüsü Dergisi , 11 (1) , 737-754. DOI:
<https://doi.org/10.17218/hititsosbil.332294>
- Palmer, D. The POE in the primary school: An evaluation. *Research in Science Education* 25, 323-332 (1995).
<https://doi.org/10.1007/BF02357405>
- Rahayu, P., Widiyatmoko, A., & Hartono, H. (2015). Penerapan strategi POE (predict-observe-explain) dengan metode learning journals dalam pembelajaran IPA untuk meningkatkan pemahaman konsep dan keterampilan proses sains. *Unnes Science Education Journal*, 4(3). 1014-1021. DOI:
<https://doi.org/10.15294/usej.v4i3.8853>
- Rutten, N., van Joolingen, W. R., & van der Veen, J. T. (2012). The learning effects of computer simulations in science education. *Computers & Education*, 58(1), 136-153. DOI:
<https://doi.org/10.1016/j.compedu.2011.07.017>
- Safitri, N., Agnafia, D. N., & Anfa, Q. (2024). The effect of the predict observe and explain learning model on critical thinking ability of junior high school students on environmental pollution. *BIO-NOVED: Jurnal Biologi-Inovasi Pendidikan*, 6(1), 119-124. DOI:
<http://dx.doi.org/10.20527/bino.v6i1.16268>
- Sarah, S., Khanif, A., & Saputra, A. T. (2021). The effectiveness of POE (predict-observe-explain) learning model for improving student analytical skills. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, 6(1), 23-29. DOI:
<http://dx.doi.org/10.26737/jipf.v6i1.1846>
- Sertkaya, Ö. F. (2018). 8.sınıf fen bilimleri dersi basit makineler ünitesinde ALGODOO yazılımı ile desteklenen 5E modelinin öğrenci başarı ve tutumuna etkisinin incelenmesi [Master's thesis]. Fırat University.
- Setiyani, T. W., Churiyah, M., & Arief, M. (2019). Enhancing the students' critical thinking ability and learning outcome through POE learning model. *Jurnal Administrare: Jurnal Pemikiran Ilmiah Dan Pendidikan Administrasi Perkantoran*, 6(1), 61-72. DOI:
<https://doi.org/10.26858/ja.v6i1.9700>
- Simanjuntak, M. P., Hutahaean, J., Marpaung, N., & Ramadhani, D. (2021). Effectiveness of Problem-Based Learning Combined with Computer Simulation on Students' Problem-Solving and Creative Thinking Skills. *International Journal of Instruction*, 14(3), 519-534. DOI:
<https://doi.org/10.29333/iji.2021.14330a>
- Son, Y.-J., & Song, Y.-A. (2012). Effects of Simulation and Problem-Based Learning Courses on Student Critical Thinking, Problem Solving Abilities and Learning. *The Journal of Korean Academic Society of Nursing Education. The Korean Academic Society of Nursing Education*.
<https://doi.org/10.5977/jkasne.2012.18.1.043>
- Şahin, S. (2006). Computer simulations in science education: Implications for distance education. *Turkish Online Journal of Distance Education*, 7(4), 132-146.
- Tao, P. K., ve Gunstone, R., (1999). Conceptual change in science through collaborative

- learning at the computer. International Journal of Science Education, 21(1), 39-57. DOI: <https://doi.org/10.1080/095006999290822>
- Taylor, I., Barker, M. ve Jones, A. (2003). Astronomi eğitiminde zihinsel model oluşturmayı teşvik etmek. Uluslararası Bilim Eğitimi Dergisi , 25 (10), 1205-1225. <https://doi.org/10.1080/0950069022000017270a>
- Tekin, S. (2008). Kimya laboratuvarının etkinliğinin aksiyon araştırması yaklaşımıyla geliştirilmesi. Kastamonu Eğitim Dergisi, 16(2), 567-576. <https://dergipark.org.tr/tr/pub/kefdergi/issue/49100/626534>
- Uriyah, N., & Supardi, Z. A. I. (2023). Effectiveness of POE Learning Model on Science Process Skills in Temperature and Heat of Elementary Students. Studies in Philosophy of Science and Education, 4(2), 66-76. DOI: <https://doi.org/10.46627/sipose.v4i2.283>
- White, R. & Gunstone, R. (1992) Probing Understanding, USA: Routledge Taylor & Francis Group.
- Winn, W. & Synder, D. (1996). Cognitive perspectives in psychology. In D. Jonassen (Ed.), Handbook of research on educational communications and technology. New York: Simon & Schuster.
- Yenice, N., Alpak Tunç, G., & Candarlı, F. (2019). Fen Eğitiminde TGA Uygulamasının 6. Sınıf Öğrencilerinin Problem Çözme Becerileri Üzerindeki Etkisinin İncelenmesi. İnönü Üniversitesi Eğitim Bilimleri Enstitüsü Dergisi, 6(11), 16-27. DOI: <https://doi.org/10.29129/inujse.455848>
- Zorlu, Y. (2016). Ortaokul Fen ve Teknoloji Dersinde İşbirlikli Öğrenme Modeli ve Modellemeye Dayalı Öğretim Yöntemine Dayalı Etkinliklerin Öğrencilerin Öğrenmeleri Üzerindeki Etkileri. [Master's thesis]. Atatürk University, Erzurum.

Received: December 10, 2024

Revised: January 12, 2025

Accepted: January 30, 2025