IJELS Educating for the Future

International Journal of Education & Literacy Studies
ISSN: 2202-9478
www.ijels.aiac.org.au

AIAC Flourishing Creativity & Literacy

Effect of Hands-On Science Activities on Students' Academic Achievement and Scientific Attitude

Gamze Kırılmazkaya[1]*, Sena Nur Dal[2]

[1]*Department of Mathematic and Science Education, Faculty of Education, Harran University, Şanlıurfa, Turkey*
[2]*T.R. Ministry of National Education, Şanlıurfa, Turkey*

Corresponding author: Gamze Kırılmazkaya, E-mail: gamzekirilmazkaya@gmail.com

ARTICLE INFO

Article history
Received: September 01, 2022
Accepted: October 19, 2022
Published: October 31, 2022
Volume: 10 Issue: 4

Conflicts of interest: None
Funding: None

ABSTRACT

In this study, it is aimed to investigate whether the science course taught by using simple tools has an effect on academic achievement and attitude towards science. For this purpose, a quasi-experimental model with pretest-posttest control group was used. The study group of this research consists of a total of 40 students, 21 (52.5%) girls and 19 (47.5%) boys, studying in a secondary school in the southeast of Turkey in the 2021-2022 academic year. The "Force and Energy achievement test" was used to determine the effect of science activities with simple tools on the academic achievement of students. the "Attitude towards Science Scale" was used in order to determine students' attitudes towards science. The data obtained from the data collection tools used in the study were analyzed with the SPSS program. As a result of the research, it was determined that the activities performed with simple tools were effective in student success. This shows that the activities made with simple equipment are more effective on the academic success of the student than the traditional method. In the study, a significant difference was found in favor of the experimental group when the scientific attitude scale results of the control group taught with the traditional approach and the science activities performed with simple tools and the experimental group were compared. In conclusion, it was determined that science activities made with simple tools from student diaries create positive attitudes.

Key words: Academic Achievement, Scientific Attitude, Force and Energy, Hands-on Science

INTRODUCTION

In parallel with the developments in science and technology, in the age of rapid chanegs, information is an important power in the economic development of countries and in reaching the status of a developed society (Alkan Dilbaz et al., 2016). In the information age, the need for creative, qualified, enterprising and productive individuals who know the ways of accessing information, cares about the principles of democratic society, can use information technologies, are open to change, have advanced communication skills, think critically, are prone to teamwork, can solve problems, do research, is increasing. A quality science education is needed in raising individuals who have these characteristics. It is predicated for a quality scientific education on John Dewey's learning-by-doing approach. According to this approach, in science education around the world, it is tried to use a learning approach in which students take an active part in the process, take responsibility for their own learning and construct knowledge, and the teacher guides them National Center for Improving Science Education,(1995). "Hands-on learning" is defined as a method that includes the processes of observing, explaining, comprehending and thinking about an event or phenomenon with the help of tools that students create with simple materials they use in daily life. In the lessons enriched with simple materials, students who learn by doing and living with their own experiences comprehend the new information transferred more easily and better. Besides, even students who were previously uninterested in the lessons are motivated by simple tools and begin to be more active in the lessons. In this way, new information becomes more permanent than information learned by reading or listening, as they discover scientific concepts by experiencing them themselves. Since the selection of simple materials from daily life ensures cheap tools, equality among students in terms of socio-economic level is ensured. Through these experiments, since the information is not memorized, students can make inferences by observing their own experiments and can establish the cause-effect relationship more easily. In addition, it was stated that students who experimented with simple materials had an increase in their ability to use materials in the laboratory, to graph the experimental data, and to make comments by looking at the graphs (Eryılmaz & Hardal, 2004). Science experiments and activities carried out with simple equipment play a major role in the development of many skills of students, such as psychomotor skills (Kontra et al., 2015). Various materials and equipments that allow students to develop their scientific skills such as data

Published by Australian International Academic Centre PTY.LTD.

http://dx.doi.org/10.7575/aiac.ijels.v.10n.4p.56

collection, observation and measurement are available in the applied laboratory environment (de Jong et al., 2013). For this reason, science experiments with simple tools enable students to acquire knowledge and skills to design experiments with simple tools by experimenting many times; while preparing the experimental setup, it enables them to comprehend the nature, basic concepts, principles and laws of science easily and in a short time (Uzal et al., 2010). Teaching science with simple tools also positively affects students' science achievement, progress in science process skills, and attitudes towards science (Yu & Bethel, 1991). There are not equal opportunities for laboratory materials in every educational environment. In order to partially eliminate the inequality of opportunity in science education, science activities with simple tools should be attached great importance. The region where the study was conducted is the most disadvantaged region of Turkey. The study was conducted with students in a school in this disadvantaged area (Table 1). Therefore, in this study, it is aimed to investigate whether the science course taught by using simple tools has an effect on academic achievement and attitude towards science. The aim of this research is to see the effect of experiment activities that can be done with simple tools in science lessons on students' academic achievement and scientific attitudes. The main problem of the research is "Does experiment activities that can be done with simple tools in science teaching have an effect on students' academic success and attitudes towards science?" creates the question. The following sub-problems were created within the framework of the main problem:

1. Is there a significant difference between the activities created with simple tools and the academic achievement levels of the students?
2. Is there a significant difference between the activities created with simple tools and the scientific attitude scores of the students?
3. What are the students' views on science experiments with simple tools?

Table 1. Demographic characteristics of the students participating in the study

Characteristics	***f***	**%**
Sex		
Girl	21	52.5
Boy	19	47.5
Education status of mother		
Illiterate	20	50
Primary school	12	30
Secondary school	8	20
Education status of father		
Illiterate	10	25
Primary school	20	50
Secondary school	10	25
Number of siblings		

METHOD

In the research, a quasi-experimental method with pretest-posttest control group was used. The reason for choosing the quasi-experimental method is that it is not possible for the students in the sample to be assigned to the experimental and control groups impartially. The hypotheses of the research were evaluated according to the pretest-posttest results obtained. The evaluation of the findings obtained from the pretest and post-test results was supported by the opinions in the diaries written by the students.

Participants

The study group of this research consists of a total of 40 students, 21 (52.5%) girls and 19 (47.5%) boys, studying in a secondary school in the southeast of Turkey in the 2021-2022 academic year. Demographic characteristics of the students participating in the study are presented in Table 1.

When the demographic characteristics given in Table 1 are examined, it can be said that the students studying at the school where the study was conducted are at a low socio-economic level. In addition, there is no laboratory classroom and experimental materials in the school where the study was conducted.

Data Collection Tools

In the study, the "Force and Energy achievement test" created by Güngörmez and Akgün (2018) was used to determine the effect of science activities with simple tools on the academic achievement of students. There are 20 questions in the achievement test and the Kuder-Richardson 20 coefficient value of the test was found to be 0.76. As a result of the item analysis and internal consistency analysis, it was decided to use the test in the study because it is a test with average difficulty, high discrimination, valid and high reliability values (Güngörmez & Akgün, 2018). In the study, the "Attitude towards Science Scale" developed by Moore and Foy (1997) and adapted into Turkish by Demirbaş and Yağbasan (2006) was used in order to determine students' attitudes towards science. The Attitude Towards Science Scale, which is a Likert type, consists of 40 items in total (Demirbaş, & Yağbasan, 2006). The Cronbach Alpha reliability coefficient of the scale was found 0.76, and the Spearman Brown two-half test correlation coefficient was found 0.84.

Application Steps of the Research

In the research, the unit "Force and Energy" was chosen in order to determine the effect of activities performed with

simple equipment on the success and scientific attitude of the students. The subject of "Force and Energy" is among the subjects that students have difficulty in understanding and have misconceptions due to the many abstract concepts (Bozan & Küçüközer, 2007; Gürses et al., 2002; Nuhoğlu, 2008; Koç & Böyük, 2012). Therefore, this topic was chosen in this study. Firstly, Academic Achievement Test and Attitude towards Science Scale were applied to the experimental and control groups as a pretest. The activities applied in the research are shown in Table 2. In addition, worksheets were prepared by the researchers to be used in the activities and the evaluation phase of the activities was completed with these worksheets. The researchers guided the students throughout the implementation process of the activities.

Worksheets were distributed to the students in the experimental group in which the students were active. The students were asked to review the activities and fill in the worksheets before the activity. The students provided the activity materials themselves. The students kept a diary about the activities done during the process. In the control group, lessons were taught in accordance with the curriculum. At the end of the application, the academic achievement test and the attitude towards science scale were applied to the experimental and control groups as a post-test.

Table 2. Experiments applied in the research

Experimental activity name	Used simple materials
1. Let's make our own dynamometer	Rubber band, ruler, 100-200-300 grams of rice, graph paper
2. Bouncing pen	Ballpoint pen, stapler
3. Movement of marbles	various sized marbles
4. use of leverage	long ruler, eraser, book, dynamometer
5. Fixed pulley	Pulley, rope, ruler, tripod, dynamometer, object
6. The orange is falling	Orange, cup, postcard, matchbox
7. Laxness of money	5 thick coins, dinner knife
8. How can we reduce friction?	Hand cream
9. What does friction depend on?	Marbles of various sizes, piece of cloth

Analysis of Data

The data obtained from the data collection tools used in the study were analyzed with the SPSS program. The analyzes were made in the context of quantitative data analysis, so the steps applied for each measurement tool proceeded similarly. In the study, t tests were used for pairwise comparisons between groups. In order to determine the test to be used when comparing the groups, the normality distribution was examined with the Shapiro Wilk test and the results in Table 3 were obtained.

Table 3. Shapiro Wilk test results of achievement and attitude measurement tools

Groups	Test	Achievement test		Attitude test	
		Statistic	p	Statistic	p
Experiment	Pretest	0.936	0.097	0.945	0.204
	Post-test	0.956	0.158	0.914	0.130
Control	Pretest	0.934	0.131	0.947	0.689
	Post-test	0.982	0.157	0.940	0.531

In Table 3, both the pretest and posttests of the experimental and control groups show normal distribution for achievement test and attitude tests ($p>.05$). Another factor in determining the tests to be applied in the study is the comparison of the pretests of the groups for each variable. Based on Table 4, independent t-test was used in the pretest comparison for the tests. The results are in Table 4.

When Table 4 is examined, no significant difference was found between the experimental and control groups in terms of academic achievement and scientific attitude scale pretests ($p>0.05$). Accordingly, it can be said that there is no difference in terms of scientific attitudes and academic achievement of the students in both groups before the study.

RESULTS

Another one the sub-problems of the research is "Do the activities created with simple tools have a significant effect on the academic achievement of the students?" In order to find an answer to the question, the data obtained from the posttest scores of the experimental and control groups were analyzed with the independent t-test (Table 5).

The "Force and Energy Unit Academic Achievement Test Results", which was applied as a post-test at the end of the application, are presented in Table 5. When the values obtained were examined, the control group post-test success score was 65.34 (SD=18.57), and the experimental group's post-test success score was 71.59 (SD=20.94). According to the independent t-test results, a significant difference was found between the achievement scores of the experimental and control groups ($t=3.806$, $p<.05$). According to these findings, it was determined that there was a difference between the post-test averages of the experimental and control groups and this difference was in favor of the experimental group. In this case, looking at the results obtained, it can be said that science experiments with simple tools affect academic achievement positively.

At the end of the application, the achievement test findings regarding the pretest and post-test scores of the control group are presented in Table 6. Considering the obtained values, a significant difference was found between the pretest and post-test achievement scores of the experimental ($t=-3.36$, $p<.05$) and control ($t=11.46$, $p<.05$) groups.

There was an increase in success in the posttests of both groups, but the increase in the experimental group was greater than the increase in the control group. From the result, it can be said that science experiments with simple tools increase success more than the traditional teaching approach.

Table 4. Independent t-test results of academic achievement and scientific attitude scale pretest scores

Tests	Group	n	M	SD	t	p
Achievement pretest	Experiment	20	32.52	19.29	-0.846	0.403
	Control	20	27.84	15.52		
Scientific attitude pretest	Experiment	20	124.00	10.84	0.607	0.719
	Control	20	125.90	12.28		

Another aim of the study is to examine the effects of science experiments with simple tools on students' scientific attitudes. The findings obtained from the Scientific Attitude Scale, which was applied as a post-test to the control and experimental groups as a result of the application, are presented in Table 7.

Looking at the values in Table 7, it is seen that the post-test success score of the experimental group was 133.2 (SD=9.78), and the post-test success score of the control group was 127.15 (SD=11.34). The scientific attitude scale scores of the experimental group students were higher than the control group. However, there is no relationship between this difference and the means (t=1.806, p>.05).

In Table 8, it is seen that the mean attitude of the control group students was 125.9 (SD=12.28), and the average of the final attitude was 127.15 (SD=11.34). Accordingly, it was determined that there was no statistically significant difference between the pretest and post-test scientific attitude scores of the control group students (t=-0.680, p>.05). It is seen that the preliminary attitude average of the experimental group students was 124 (SD=10.8) and the final attitude average was 133.20 (SD=9.78). Accordingly, there is a relationship between pretest and posttest attitude scores in the experimental group (t=-3.178, p<.05).

In the study, students were asked to keep a diary about the activities. The students' feelings and thoughts about the teaching of the lesson are as follows: "The lesson is fun. I want to do more experiments and spend more time in the laboratory." "Our lesson was very fun, even those who did not like the lesson wanted to do the experiments. We brought the materials we used easily. I could understand the subject easily, it stayed in my mind more because I tried it." "I learn better when there are experiments." "I participate in classes in cooperation with my groupmates." ' "I always want to teach science lessons like this now." "I learned how fun it is to experiment." "I loved the experiments I did, I wanted to try them all again when I got home. "Our lessons were very exciting, I didn't even hear the recess bell most of the time, thank you very much to my teacher for the experiments we did, it was easy and we had a lot of fun."

Table 5. Independent t-test results of academic achievement posttest scores of experimental and control groups

	Group	n	M	SD	t	p
Posttest	Experiment	20	71.59	20.94	3.806	0.001
	Control	20	65.34	18.57		

Table 6. Dependent t-test results regarding the difference between academic achievement pretest-posttest scores

Group	Tests	n	M	SD	t	p
Control	Pretest	20	27.84	15.52	-11.46	0.000
	Posttest	20	65.34	18.57		
Experiment	Pretest	20	32.52	19.29	-3.36	0.010
	Posttest	20	71.59	20.94		

Table 7. Experimental and control group scientific attitude scale post-test scores, independent t-test results

	Tests	n	M	SD	t	p
Post-test	Experiment	20	133.20	9.78	1.806	0.079
	Control	20	127.15	11.34		

Table 8. Scientific attitude scale pretest-posttest scores dependent t-test results

Group	Tests	n	M	ss	t	p
Control	Pretest	20	125.90	12.28	0.68	0.510
	Posttest	20	127.15	11.34		
Experiment	Pretest	20	124.00	10.84	-3.17	0.010
	Posttest	20	133.20	9.78		

DISCUSSION

In this study, the effect of science experiments with simple equipment on students' academic achievement and attitudes towards science was investigated. As a result of the research, it was determined that the activities performed with simple tools were effective in student success. This shows that the activities made with simple equipment are more effective on the academic success of the student than the traditional method. When the literature is examined, there are studies that reveal the positive effects of simple tools on academic achievement. One of these studies was carried out by Başkurt (2009). Başkurt (2009) found that the lessons taught with simple equipment showed improvement in the academic achievement levels of the students in his study in which he applied simple science activities using environmental materials in the unit "Force and Motion" (Başkurt, 2009). In studies on different subjects, it has been determined that simple tools increase students' science achievement. For example, Eryılmaz and Hardal (2004) concluded that the physics achievements of the students in the activities related to electrical circuits according to the learning by doing method with simple tools were higher than the physics achievements of the students to whom the traditional teaching method was applied. Karamustafaoğlu et al. (2005) determined that there

was a significant difference in favor of the experimental group in science achievements in the experimental group, in which the periodic table prepared with simple instruments was used, compared to the control group, which was applied with the traditional method. In the study, it was also determined that the experimental group students found the activities very enjoyable and useful.

In the study, a significant difference was found in favor of the experimental group when the scientific attitude scale results of the control group taught with the traditional approach and the science activities performed with simple tools and the experimental group were compared. In line with this finding, it can be said that the experimental activities carried out with the simple tools and equipment applied in the experimental group were significantly effective in increasing the scientific attitudes of the students. This result is in line with the studies in the related literature in which experimental activities with simple tools have an effect on increasing positive attitudes towards science (Ateş & Eryılmaz, 2011; Bilgin, 2006; Karamustafaoğlu et al., 2005; Leung 2008; Paris et al., 1998; Stohr-Hunt, 1996; Holstermann et al., 2010; Satterthwait, 2010; Sadi & Çakıroğlu, 2011; Uyanık, 2018). In his research, Uyanık (2018) found that experiments with simple tools and equipment applied in the experimental group increased both the academic success of the Science course and the positive attitudes towards science. Başdaş (2007) found that science activities made with simple and inexpensive materials were effective in improving students' science process skills. Similarly, Bilgin (2006) found that activities made with simple and inexpensive materials improved students' scientific process skills and attitudes towards science. In the research of Koç and Böyük (2012), experiments with simple materials caused students to like science lesson very much, find it fun and increase students' interest in the lesson.

CONCLUSION

In the study, it was determined that science activities made with simple tools from student diaries create positive attitudes. The positive effect of the activities done by doing and living on the learning of the students is shown in this study. It can be said that as a result of experiments with simple materials, students love the lesson and increase their interest. In the study, the students were provided with activities and experiments using the materials they were familiar with. In the study, it was shown that science activities can be done outside the laboratory and it was tried to make students realize that science lesson is a part of daily life. In science lessons, choosing experiments and activities that can be done with easy-to-find, non-hazardous inexpensive materials instead of special and expensive laboratory materials made science lessons more enjoyable. It can be deduced that this situation reduces the fear of students towards science lessons and causes students to like science more. The content of the policies made on the Turkish Education System (TES) is to determine whether the phenomenon of "equal opportunity" reflects on the social success targeted by education and whether it provides justice. In addition, by drawing attention to existing inequalities, practices that reduce the effects of inequality should be included. Within the scope of the research, various teacher and student guides can be prepared so that simple tools can be applied more clearly by teachers and students. The time allocated for the preparation of experiments and teaching should be well planned. The impact of the research on students at other education levels can be explored. Simple science activities can be implemented in different units or subjects. Various trainings can be given to teachers in order to have the necessary competencies in determining, developing and using these materials and to demonstrate these competencies in practice.

REFERENCES

Alkan-Dilbaz, G., Yanpar-Yelken, T., & Özgelen, S. (2016). The Effects of ınquiry-based learning on attitude towards science and technology course and inquiry skills. *Elementary Education Online*, *15*(2), 708-722.

Ateş, Ö., & Eryılmaz, A. (2011). Effectiveness of hands-on and minds-on activities on students' achievement and attitudes towards physics. *Asia-Pacific Forum on Science Learning and Teaching, 12*(1), 1-22.

Başdaş, E. (2007). *The effect of science activities made with simple materials on scientific process skills, academic success and motivation in primary school science education* [Master's Thesis]. Celal Bayar University, Institute of Science and Technology, Manisa.

Başkurt, P. (2009). *The effect of teaching the force and motion unit in 8th grade science and technology course with simple materials on success, persistence and attitude* [Master's Thesis]. Gazi University, Ankara.

Bilgin, İ. (2006). The effects of hands-on activities incorporating a cooperative learning approach on eight grade students' science process skills and attitudes toward science. *Journal of Baltic Science Education, 1*(9), 27-37.

Bozan, M., & Küçüközer, H. (2007). Elemantary school students' errors in solving problems releated to pressure subjects. *Elementary Education Online, 6*(1), 24-34.

Demirbaş, M. & Yağbasan, R. (2006). Functional importance of scientific attitudes in science teaching and adaptation study of scientific attitude scale into Turkish. *Journal of the Faculty of Education XIX* (2), 271-299.

Eryılmaz, A., & Hardal, Ö. (2004). Activities related to electric circuits developed according to learning by doing method with simple tools <http://www.erg.sabanciuniv.edu/iok2004/bildiriler/Ozlem%20Hardal.doc> (10.06.21)

de Jong, T., Linn, M. C., & Zacharia, Z. C. (2013). Physical and virtual laboratories in science and engineering education. *Science, 340*(6130), 305-308.

Gülmez Güngörmez, H., & Akgün, A. (2018) An academic achievement test development study for the force and energy unit in the science course of secondary school students. *Dialectolog National Journal of Social Sciences, 18*(85-99).

Gürses, A., Doğan, Ç., Yalçın, M. & Canpolat, N. (2002). *The Effect of conceptual change approach on students' understanding of gases*. V. National Science and Mathematics Education Congress, (16-18 September 2002). Middle East Technical University, Ankara.

Karamustafaoğlu, S., Coştu, B., & Ayas, A. (2005). Effectiveness of periodic table teaching with simple tools. *Turkish Journal of Science Education, 2*(1).

Karasar, N. (2005). *Scientific research method*. Ankara: Nobel Publishing House.

Koç, A., & Böyük, U. (2012). The effect of experiments with simple materials on the attitude towards science. *Journal of Turkish Science Education, 9*(4), 102-118.

Kontra, C., Lyons, D. J., Fischer, S. M., & Beilock, S. L. (2015). Physical experience enhances science learning. *Psychological Science, 26*(6), 737-749.

Leung, C. B. (2008). Preschoolers' acquisition of scientific vocabulary through repeated read aloud events, retellings, and hands-on science activities. *Reading Psychology*, *29*, 65-193.

Moore, W. R, & Foy, R. (1997). The Scientific Attitude Inventory: A Revision (SAI II) *Journal of Research in Science Teaching, 34*(4), 327-336.

National Center for Improving Science Education (NCISE). (1995). Providing hands-on, minds-on and authentic learning experiences in science, 28.03.2022, http://www.ncrel.org/sdrs/areas/issues/content/cntareas/science/sc500.htm

Nuhoğlu, H. (2008). Evaluation of primary school students' knowledge about motion and force. *Journal of Inonu University Faculty of Education, 9*(16), 123–140.

Paris, S. G., Yambor, K. M., & Packard, B. W. (1998). A museum-school university partnership for enhancing students' interest and learning in science. *The Elementary School Journal, 98*(3), 267-288.

Uyanık, G. (2018). The effect of experiments with simple equipment on attitudes, academic achievement and permanence towards science course. *OPUS International Journal of Society Researches, 9*(16), 600-624. DOI: 10.26466/opus.462761

Uzal, S., Erdem, A., Önen, F., & Gürdal, A. (2010). Teachers' views on science experiments with simple equipment and evaluation of in-service training. *Necatibey Education Faculty Electronic Journal of Science and Mathematics Education, 4*(1), 64-84.

Sadi, Ö., & Çakıroğlu, J. (2011). Effects of hands-on activity enriched in- struction on students' achievement and attitudes towards science. *Journal of Baltic Science Education*, *10*(2), 87-97.

Satterthwait, D. (2010). Why are hands-on science activities so effective for student learning? *Teaching Science, 56*(2), 7-10.

Stohr-Hunt, P. M. (1996). An analysis of frequency of hands-on experience and science achievement. *Journal of Research in Science Teaching, 33*(1), 101-109.

Yu, S. M., & Bethel, L. J. (1991). *The influence of hands on science process skills traininş on preservice elementary teachers' anxiety and concerns about teachinş science activities in Taiwan, republic of China*. The Annual Meeting of the National Association for Research in Science Teaching, Lake Geneva (April 7-10, 1991).