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THE INVESTIGATION OF THE EFFECTS OF ROBOTIC-ASSISTED PRACTICES IN TEACHING RENEWABLE ENERGY SOURCES TO SEVENTH-GRADE STUDENTS IN SECONDARY SCHOOL

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Abstract: The purpose of the study is to teach the robotics-assisted lego training sets and renewable energy sources to 7th grade students in secondary school and examine the effects of practices on academic achievement and scientific process skills of students. The research was carried out with 20 students which study in the 7th grade of secondary school. A single group pre-test-post test model which is one of the pre-test designs, was used in the study. In the research, it was tried to be taught the renewable energy sources to students by using the Lego® Mindstorms EV3 Training Kit and the Lego® Renewable Energy Kit. The practice lasted total for 20 hours as 3 stages. At the first stage, Lego® Mindstorms EV3 Training Kit and Lego® Renewable Energy Kit were introduced to the students. At the second stage of the practice solar energy related materials and at the final stage wind energy materials of the practice were ensured to be designed by students, and it was made them do activities. In the research, as a mean of collecting data, "Alternative Energy Resources Achievement Test" developed by Mercan Hbek (2014) in order to measure the success of students on the topic of renewable and non-renewable energy sources, "Scientific Process Skill Test" developed by Okey, Wise and Burns (1985) and translated and adapted to Turkish by Geban, Akar and zkan (1992) in order to determine whether there is any change in the scientific process skills of the students and "Semi-structured interview form" in order to evaluate the perspectives of students on the use of legos as a course material, were used. The data obtained in the study were evaluated through the SPSS package program. In the light of this study, it was determined how students perceive education with legos as a method oriented the subject of renewable energy sources.

Keywords: Robotic, renewable energy resources, lego® mindstorms EV3 educatin kit, lego® renewable energy kit

Introduction

It is now clear that science and technology education plays an important role in the future of societies, as scientific knowledge grows, technological innovations progress rapidly, and the effects of science and technology are clearly visible in all areas of our lives (Mercan Hbek, 2014). Recently, many innovative approach-based applications have been implemented in the field of education. A number of innovation activities have been carried out in which the learning environment is enriched, in which remedial materials for conceptual misconceptions about a specific topic are used, in which the students are responsible for their own learning in the process and they work in cooperation with their peers and using social communication skills, and also, teachers working as guides in the process. One of the innovative works used in these activities is the Lego-Logo supported learning environment (Silik, 2016).

Students trained in the learning environment created with Lego robot kits have fulfilled the stages of thinking, analysing, formulating the results, reaching the knowledge and searching for the answers (zdođru, 2013). According to Costa and Fernandes (2004), learning environments provided by Robotics contribute to the development of many skills that students already have. Robotics activities in Science and Technology education have shown that students have acquired many abilities such as problem-solving, finding practical solutions to problems, critical thinking, awareness of their own abilities, learning by doing living, increasing the level of using technology and being more willing to use technology (Silik, 2016).

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When the studies in which the robotics are used in the literature are examined; In a study conducted by Özdoğru (2013), it was found that the use of Lego Mindstorms NXT 2.0 has a positive effect on students' scientific process skills, academic achievement, attitudes towards science and technology. In the studies conducted by Koç Şenol and Büyük (2015), experiments carried out with robotic support, examines the effects of students on scientific process skills and motivation for science and technology lessons in the Science and Technology lesson "Force and Movement"s unit, it was found that robotics significantly influenced students' motivation for scientific process skills and science and technology lessons. In the study of Payne (2008), as a result of the study of robotic courses investigating effects on primary school students, emphasised that sense of responsibility, creativity, analysis and synthesis skills, collaborative learning and independent working skills, communication and problem-solving skills improved in the students. Ma, Lai, Prejean, Ford and Williams (2007) found that robotic activities helped middle school students learn better about physical knowledge. In their study, Lindh and Holgersson (2007) also found that the success of students who love problem-solving activities, increased and the students who received lego training, were more successful the next year.

In this context, this research aims to teach renewable energy sources to the 7th-grade students of middle school with robotically supported lego training sets and to examine the impact of their application on academic achievement and scientific process skills of students.

Methods

This research is a study aimed to teach renewable energy sources to the 7th-grade students of middle school with robotically supported lego training sets and to examine the impact of their application on academic achievement and scientific process skills of students. In the study, one group pre-test-post test model was used from pre-test designs. Students in the study were tried to be taught renewable energy sources by using Lego® Mindstorms EV3 Training Kit and Lego® Renewable Energy Kit. The set includes solar energy panel, wind turbine propellers, LED lights, motor, energy meter to measure energy produced and 6 different production guides. The application lasted for 3 stages in total for 20 hours. In the first stage, students were introduced Lego® Mindstorms EV3 Training Kit and Lego® Renewable Energy Kit. In the second stage of the application, solar energy related materials and in the last stage of the application, materials related to wind energy were designed and activities were done.

Data Collection Tools

The Alternative Energy Sources Achievement Test developed by Mercan Hübek (2014) ,in order to measure the success of the students as a means of collecting data in the research in terms of renewable and non-renewable energy sources; Science Process Skills Test (SPST) which was developed by Okey, Wise and Burns (1985) and translated and adapted by Geban, Aşkar and Özkan (1992) to determine whether there is any change in the scientific process skills of the students, "Robotic Preliminary Questionnaire" developed by Riberio (2006) and translated into Turkish by Koç Şenol (2012), Robotic Satisfaction Test developed by Silva (2008) and Gibbon (2007) and translated into Turkish by Koç Şenol (2012) and a semi-structured interview form to assess students' views of the use of legos as lesson material and to determine their views and recommendations on implementation, were used as data collection tools in the research.

Results and Findings

A total of 20 middle school 7th grade students including 10 girls and 10 boys participated in the research. Alternative Energy Resources Achievement Test consisting of 19 multiple choice and 3 open ended questions in order to measure the success of students on the topic of renewable and non-renewable energy sources, Scientific Process Skill Test, "Robotic Preliminary Questionnaire", "Robotic Satisfaction Test" for students to determine whether there is any change in scientific process skills and a semi-structured interview form to assess students' views of the use of legos as lesson material and to determine their views and recommendations on implementation, were used as data collection tools in the research. Multiple-choice questions and open-ended questions on alternative energy sources achievement test were evaluated separately. The 19 multiple choice questions were each rated 1 point and the highest score was 19 points. The data obtained from the study were evaluated by means of the SPSS package program and the data obtained are presented below.

Table 1. SPST pretest-posttest scores of the students

	<i>N</i>	\bar{X}	<i>SS</i>	<i>t</i>	<i>df</i>	<i>p</i>
Pre-test	20	0,55	0,16	3,37	19	0,03
Post-test	20	0,67	0,11			

When Table 1 is examined, it is seen that students' scientific process skills test have a pre-test score average 0.55; And the posttest score average is 0.67. As the t-test result ($t_{19} = 0.03$; $p < 0.05$) on these values, it is seen that there is a statistically significant difference between students average of pre-test-post test scores in scientific process ability test. Therefore, it can be said that the robotic activities contributed positively to the students' scientific process skills.

Table 2. Results of AERAT pretest-posttest scores of students

	<i>N</i>	\bar{X}	<i>SS</i>	<i>t</i>	<i>df</i>	<i>p</i>
Pre-test	20	0,62	0,22	4,54	19	0,00
Post-test	20	0,78	0,14			

When Table 1 is examined, it is seen that students' scientific process skills test have a pre-test score average 0.55; And the posttest score average is 0.67. As the t-test result ($t_{19} = 0.03$; $p < 0.05$) on these values, it is seen that there is a statistically significant difference between students average of pre-test-post test scores in scientific process ability test. Therefore, it can be said that the robotic activities contributed positively to the students' scientific process skills.

Table 3. Frequency and percentage distributions of answers given by students to AERAT open-ended questions

	Very good		Good		Middle		Developable		Not good											
	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test	Pre-test	Post-test										
	f	%	f	%	f	%	f	%	f	%										
What are the most commonly used energy sources in our country, why?	1	5	4	20	4	20	7	35	8	40	8	40	3	15	1	5	4	20	0	0
What do you understand from renewable energy sources?	0	0	4	20	10	50	13	65	3	15	3	15	1	5	0	0	6	30	0	0
What are the contributions of renewable energy sources to my country?	0	0	6	30	8	40	6	30	4	20	5	25	0	0	1	5	8	40	2	10

In the study, students were asked question, "What are the most commonly used energy sources in our country and why?", the number of students who answered "good" and "very good", increased from 5 in the pre-test to 11 in the post-test and no change in the middle response. In evaluating the answers to the questions, answers such as the fossil fuels (coal, natural gas, oil), hydroelectric power plants, wind power plants and thermal power plants have been evaluated as a very good.

Students were asked question, "What do you understand from renewable energy sources", the number of students who answered "good" and "very good", increased from 10 in the pre-test to 17 in the post-test and no change in the middle response. In evaluating the answers to the questions, answers such as self-renewable, environmentally friendly, non-reducing energy sources in nature have been evaluated as a very good.

Students were asked question, "What are the contributions of renewable energy sources to my country?", the number of students who answered "good" and "very good" increased from 10 in the pre-test to 17 in the post-test and the medium answer increased 1 point. In evaluating the answers to the questions, answers such contributing to the country's budget, improving the economy and reducing its dependency on the environment by reducing environmental pollution have been evaluated as a very good.

Table 4. Frequency and percentage distributions of questions 1 and 2 of the robotic preliminary questionnaire

	Yes		No	
	f	%	f	%
Have you ever used Lego parts before?	16	80	4	20
Do you have information about the Lego Mindstorms Robotic System?	4	20	16	80

As seen in Table 4, "Have you ever used Lego parts before?" to the question, 80% of middle school students participating in the survey answered yes, 20% of the students answered no. 20% of the middle school students who participated in the survey said they had knowledge about the Lego Mindstorms Robotic System, 80% of middle school students stated that they did not have any information.

Table 5. Frequency and percentage distributions of question 3 of the robotic preliminary questionnaire

	Yes		Undecided		Easy	
	f	%	f	%	f	%
Do you think you can learn about renewable energy sources with Lego?	16	80	4	20	0	0

As seen in Table 5, "Do you have information about the Lego Mindstorms Robotic System?" to the question, 80% of middle school students participating in the survey answered yes, 20% of the students answered no.

Table 6. Frequency and percentage distributions of question 4 of the robotic preliminary questionnaire

	Partly Difficult				Undecided				Easy			
	Pre-test		Post-test		Pre-test		Post-test		Pre-test		Post-test	
	f	%	f	%	f	%	f	%	f	%	f	%
What do you think about the use of legos in activities you performed/will perform?	0	0	4	20	5	25	0	0	15	75	16	80

"What do you think about the use of legos in activities you performed/will perform?" to the question, 25% of middle school students participating in pre-test stated that they were undecided for the use of legos in the activities they will perform and 75% stated that the use of legos will be easy. In the post-test, 20% of middle school students were found to be partly difficult and 80% stated it was easy.

Also on post-test, students were asked the question, "Are you satisfied with the activities you have done?", they stated that 15% of middle school students were satisfied, and 85% were very satisfied.

"Have you been interested in using Legos in renewable energy activities?" to the question, 100% of middle school students answered yes.

Students participating in a survey were asked "Does the Lego® Renewable Energy Set benefit from learning Renewable Energy Resources?", 100% of the students answered yes and stated it was beneficial. Some of the answers given by students are as follows:

Ö-1: "Yes it was. I also had fun. "

Ö-2: "Yes it was and I had a lot of fun."

Students participating in a survey were asked "What are the advantages of lesson processing with legos?" Some of the answers given by students are as follows:

Ö-1: "I think it will be more fun and more memorable as it will be applied "

Ö-2: "We learn by having more fun."

Ö-3: "It can stay faster and clearer in people's minds."

Ö-4: "I think it will make it easier to learn and increase the interest in the lesson."

Ö-5: "Enables student-centered lesson for applied."

Ö-6: "The lesson can be more memorable when it is applied."

Ö-7: "Lessons become more fun and educational."

Students participating in a survey were asked "What do you think about the processing of the lessons with legos?" Do you want to? Why?" Some of the answers given by students are as follows:

Ö-1: "I think it will be more fun and more memorable and more productive learning because it will be applied."

Ö-2: "I think that our learning will be more fun, more memorable and more productive for students by learning away from the memorization system, experimenting and practicing."

Ö-3: "It ensures that children (we) are not bored from the lessons and understand the lesson better."

Students participating in a survey were asked "What are the disadvantages of lectures with legos?" Some of the answers given by students are as follows:

Ö-1: "So I do not think it would be but maybe some of our friends can use it to play games instead of education."

"

Ö-2: "There may be a time problem when the lesson is being processed."

Ö-3: "I was pleased to learn with renewable energy set, but it was expensive when I asked teacher the price. In my opinion, If it is at a cheaper price, all children will be learned using it."

Conclusion

In this study, which examines the effects of teaching robotics-supported lego training sets and renewable energy sources on students' academic achievement and scientific process skills to seventh grade students in middle school, it was determined that the activities of renewable energy sources made with robotically supported lego training kits influenced the students' scientific process skills positively by analyzing the obtained data ($t_{19}=0.03$; $p<0.05$). While this result is in parallel with the results of the studies in the literature (Sullivan, (2008); Çayır, (2010); Çavaş et al., (2012); Koç Şenol (2012); Koç Senol and Büyük, (2015); Özdoğru (2013)), it also contradicts the result of the study by Ma, Lai, Prejean, Ford and Williams (2007).

From the analysis of the data obtained in the research and the responses of the students to the open-ended questions in the success tests of alternative energy sources, we can say that teaching robotics-supported lego training sets and renewable energy sources increases the knowledge of renewable energy sources. This result is parallel to the results of the study by Marulcu and Mercan Hübek (2014).

According to the results of the survey conducted before the application to determine the opinions of students related to robotics in the research, 80% of the students stated that they used Lego parts in advance, whereas 80% of the students did not know about the Lego Mindstorms Robotic System. As seen here, most of the students who participated in the research have no knowledge of robotics, even though they use the parts of the lego.

"Do you think you can learn about renewable energy sources with Lego?", 80% of the middle school students who participated in the survey had answered yes, and 20% answered no.

What do you think about the use of legos in activities you performed/will perform?" to the question, 25% of middle school students participating in pre-test stated that they were undecided for the use of legos in the activities they will perform and 75% stated that the use of legos will be easy. In the post-test, 20% of middle school students were found to be partly difficult and 80% stated it was easy.

Also on post-test, students were asked the question, "Are you satisfied with the activities you have done?", they stated that 15% of middle school students were satisfied, and 85% were very satisfied. "Have you been interested

in using Legos in renewable energy activities?" to the question, 100% of middle school students answered yes.

Students participating in a survey were asked "Does the Lego® Renewable Energy Set benefit from learning Renewable Energy Resources?", 100% of the students answered yes and stated it was beneficial.

Recommendations

In this study, which examines the effects of teaching robotics-supported lego training sets and renewable energy sources on students' academic achievement and scientific process skills in middle school students, the obtained data and moving from the results; In the study, considering that junior high school students are very satisfied with the robotics that they have been doing, that they have learned to have fun, and that their motivation for learning is increasing, various courses and activities should be organized for students and teachers on robotics which is the technology of our day.

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