THE INVESTIGATION OF THE EFFECTS OF ROBOTIC-ASSISTED PRACTICES IN THE TEACHING OF RENEWABLE ENERGY SOURCES TO SCIENCE TEACHERS CANDITATES

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ABSTRACT: It is aimed to investigate the effect of robotic-assisted practices in the teaching of renewable energy sources to science teacher candidates. Research was carried out with 20 volunteer teacher candidates who study at Artvin Çoruh University Faculty of Education in third grade of Science Teacher Education Program. A single group pre-test, post-test model was used in the study. The subject of renewable energy sources was tried to be taught to teacher candidates using the Lego® Mindstorms EV3 Training Kit and the Lego® Renewable Energy Kit. The practice lasted total of 20 hours in 3 stages. At the first stage, Lego® Mindstorms EV3 Training Kit and Lego® Renewable Energy Kit were introduced to teacher candidates. At the second stage of the practice, solar energy related materials and at the final stage of the practice, materials related to wind energy were ensured to be designed by them, and it was made them to do activities. In the research, as a mean of collecting data, "Attitude Test for Renewable Energy Sources" developed by Güneş, Alat and Gözüm (2013) in order to determine the attitudes of teacher candidates about renewable energy sources, "Renewable Energy Awareness Scale" developed by Morgil et al. (2006) and was translated into Turkish by Tiftikçi (2014) in order to measure the attitudes of teacher candidates about renewable energy sources and semi-structured interview form were used in order to determine the opinions and suggestions of the teacher candidates about the robotically assisted practice. The data obtained in the study were evaluated through the SPSS package program. In the light of this study, attitudes and awareness of teacher candidates concerning the renewable energy sources and how they perceive education with legos as a method were determined.

Keywords: robotic, renewable energy resources, lego® mindstorms EV3 educatin kit, lego® renewable energy kit, teacher candidates

INTRODUCTION

Increase in world population and increased use of technology along with developments in technology and use of more energy to sustain a convenient life standard give rise to energy need so that energy problems become a global issue. Quality of the training is crucial in order to make decisions for delivering right and effective use of energy resources that have been a bigger problem day by day (Güneş, Alat and Gözüm, 2013).

It is very important for the future of the communities that individuals adapt to these rapid developments in science and technology and benefit from the developments for their own interests (Aydınlı, 2007). According to Akkoyunlu (1998), teachers of the future should be educated as individuals who comprehend the importance of technology, are able to reach information by using technology effectively and productively, can produce and use new information and can share this information with various communication environments, can build effective communication with students, can adapt the ever-changing learning environments and can solve problems that might be encountered during learning processes (Silik, 2016). In this scope, use of robots particularly in science and technology courses and in various teaching programs, which students actively participate in, draw attention (Özdoğru, 2013). According to Wood (2003), providing teachers with a robotic teaching program that is integrated with science and technology in robotic technology area education field, and organizing advanced technology implementations on robots within learning environments ensure more meaningful and permanent learning, and the information and abilities that are acquired by learners can be used to create practical and corporate products that will ease the daily life (Silik, 2016).

It is very important to have a social sensitivity for recyclable energy resources that are crucial for our future. To ensure this must be among responsibilities of teachers who educate the future generations (Mutlu, 2016). In the most comprehensive manner, recyclable energy subject is taught with Science and Technology course. Therefore, during their undergraduate studies, Science and Technology teachers' own attitudes toward creating attitudes in their students related to energy resources are important (Güneş, Alat and Gözüm, 2013). Recyclable energy resource is a field that has been constantly developed and renewed as an interesting area. Therefore, it is very important that teachers should have an increased level of awareness and obtain a sufficient level of knowledge about recyclable energy subjects. Teachers' low level of knowledge or possible misinformation about recyclable energy subjects might lead students to have concept confusions or learn the concepts in the wrong manners (Mutlu,

2016). It is very important for teacher candidates to apply active learning methods as avoiding only memorizing information during higher education period and to become as individuals who obtain environmental awareness and responsibilities in terms of future generations to gain environmental awareness (Tiftikçi, 2014).

In this scope, it was aimed to analyze the effect of use of robotic supported implementations during recyclable energy resources education on science teacher candidates, and to determine teacher candidates' attitudes and awareness toward recyclable energy resources.

METHODS

This study aimed to identify science teacher candidates' knowledge levels related to recyclable energy resources and their opinions toward use of robotic supported implementations during teaching of recyclable energy resources. The study was conducted as single group pre-test post-test experimental design. The study group was composed of 20 teacher candidates. In the study, before starting the implementation, firstly, Attitudes Test toward Recyclable Energy Resources and Recyclable Energy Awareness Scale were applied, and semi-structured interview forms were used to determine teacher candidates' opinions and suggestions about robotic supported implementation. The implementation process used a total of 20 hours as organized within 3-phases. In the first phase, Lego® Recyclable Energy Set was introduced to teacher candidates with Lego® Mindstorms EV3 Training Set. Participants were requested to design materials related to solar energy and to make related activities in the second phase of the study. Moreover, they were requested to design materials related to wind energy and to make related activities in the third phase of the study.

Data Collection Tools

In the research, as data collection tools, "Attitudes Test Toward Recyclable Energy Resources" that was developed by Güneş, Alat and Gözüm (2013) was used to identify teacher candidates' attitudes toward recyclable energy resources. "Recyclable Energy Resources Awareness Scale" that was developed by Morgil, Seçken, Yücel, Özyalçın Oskay, Yavuz and Ural (2006) and adapted to Turkish by Tiftikçi (2014) was used to measure teacher candidates awareness levels related to recyclable energy resources. "Robotic Pre-Questionnaire" that was developed by Riberio (2006) and adapted to Turkish by Koç Şenol (2012), and "Robotic Satisfaction Test" that was developed by Silva (2008) and Gibbon (2007) and adapted to Turkish by Koç Şenol (2012) were used. Moreover, semi-structured interview forms were used to determine teacher candidates' opinions and suggestions about robotic supported implementations.

RESULTS AND FINDINGS

A total of 20 teacher candidates, as 12 of them were female and 8 of them were male, participated to the research. Before implementation process, "Robotic Pre-Questionnaire" was applied to participants to determine their opinions toward robotic supported implementations that were used in recyclable energy resources education, and after robotic implementation process, "Robotic Satisfaction Questionnaire" was applied to participants and semi-structured interview forms were applied to determine teacher candidates' opinions and suggestions about robotic supported implementations. Answers of teacher candidates, who participated to this study, for "Robotic Pre-Questionnaire" and "Robotic Satisfaction Questionnaire" were presented below in tables. In the research, "Attitudes Test toward Recyclable Energy Resources" was applied to determine teacher candidates' attitudes toward recyclable energy resources and "Recyclable Energy Resources Awareness Scale" was applied to teacher candidates to measure their awareness levels related to recyclable energy recourses, and obtained data was presented below.

Table 1. Frequency and percentage distributions of Robotic Pre-Questionnaire Question 1 and Question 2

	Yes		**No**	
	F	**%**	**f**	**%**
Have you ever used Lego parts?	9	45	11	55
Do you have any information about Lego Mindstorms Robotic System?	3	15	17	85

As seen in Table 1, for the question, "Have you ever used Lego parts? 45% of teacher candidates who participated to this research replied as "Yes" while 55% of them replied as "No". 15% of teacher candidates who participated to this research stated that they had information about Lego Mindstorms Robotic System while 85% of them stated that they did not know about this system.

Table 2. Frequency and percentage distributions of Robotic Pre-Questionnaire Question 3

	Yes		**Undecided**		**No**	
	f	**%**	**f**	**%**	**f**	**%**
Do you think that you can learn recyclable energy resources subject with the help of Legos?	10	50	10	50	0	0

As seen in Table 2, for the question, "Do you think that you can learn recyclable energy resources subject with the help of Legos?" 50% of teacher candidates who participated to this research replied as "Yes" while 50% of them replied as "No".

Table 3. Frequency and percentage distributions of Robotic Pre-Questionnaire and Robotic Satisfaction Questionnaire Question 4

	Relatively 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 use of Legos in the activities that you did/ you will do?	4	20	2	10	8	40	1	5	8	40	17	85

For the question, "What do you think about use of Legos in the activities that you did/ you will do?", in pre-test, 40% of teacher candidates who participated to this research replied as undecided for use of Legos in the activities that would be done, 40% of them replied as easy for use of Legos and 20% replied as relatively difficult for use of Legos. On the other hand, in post-test, 10% of teacher candidates replied as relatively difficult, 5% of them replied as undecided while 85% of them replied as easy.

Additionally, for the question, "What is your satisfaction level for the activities you did?", 10% of teacher candidates replied as satisfied while 90% of them replied as very satisfied.

For the question, "Did you get interested in use of Legos in recyclable energy resources activities", 100% of teacher candidates replied as "Yes".

Table 4. Frequency and percentage values of answers to items in Recyclable Energy Awareness Scale

		Definitely Disagree		**Disagree**		**Undecided**		**Agree**		**Definitely Agree**	
		f	**%**	**f**	**%**	**f**	**%**	**f**	**%**	**f**	**%**
1.	Recyclable energy resources should be effectively used to meet the increased energy demand.	0	0	0	0	1	5	6	30	13	65
2.	Public investments should be increased for recyclable energy, and effective and feasible use of recyclable energy resources.	0	0	0	0	1	5	8	40	11	55
3.	I do not think that traditional energy production methods are harmful to environment.	4	20	9	45	4	20	3	15	0	0
4.	I believe that all of the countries should use environment-friendly recyclable energy resources.	0	0	0	0	0	0	10	50	10	50
5.	I do not have much information about recyclable energy and recyclable energy resources.	5	25	8	40	7	35	0	0	0	0
6.	The current century's motto should be "use clean energy resources".	0	0	0	0	2	10	7	35	11	55
7.	I do not find use of solar and other countless clean energy resources as realistic	11	55	7	35	2	10	0	0	0	0

8.	I believe that use of recyclable energy resources is more limited when use of recyclable energy resources is compared to traditional energy resources.	5	25	7	35	2	10	4	20	2	10
9.	Use of recyclable energy resources does not decrease use of fossil fuels.	6	30	10	50	4	20	0	0	0	0
10.	I do not believe that use of recyclable energy resources will be easier for me.	8	40	9	45	3	15	0	0	0	0
11.	I am not interested in recyclable energy resources since they require more technology.	6	30	13	65	1	5	0	0	0	0
12.	I do not prefer recyclable energy resources because their usage is not easy although it is necessary for environment.	6	30	14	70	0	0	0	0	0	0
13.	I use fossil fuels but I do not have any information about their harms.	8	40	10	50	2	10	0	0	0	0
14.	Greenhouse gases, occurred due to use of fossil fuels, enable keeping heat within atmosphere. With parallel to this occurrence, I am happy with global warming.	17	85	3	15	0	0	0	0	0	0
15.	I do not believe that global warming causes a major problem.	16	80	4	20	0	0	0	0	0	0
16.	I believe that energy resources should be recyclable for ecological balance.	0	0	0	0	2	10	8	40	10	50
17.	I do not have any information about recyclable energy resources.	6	30	12	60	1	5	0	0	1	5
18.	Efforts to find new recyclable energy resources should be increased with planned energy programs.	0	0	0	0	1	5	9	45	10	50
19.	I definitely support use of recyclable energy resources.	0	0	0	0	0	0	6	30	14	70
20.	I support the production of recyclable energy resources.	0	0	0	0	1	5	5	25	14	70
21.	The concept “recyclable energy resources” makes me nervous because I am not familiar with it.	6	30	7	35	2	10	2	10	3	15
22.	Recyclable energy resources are clean energy resources at the same time.	0	0	0	0	2	10	7	35	11	55
23.	I do not believe that the difference between recyclable energy resources and unrecyclable energy resources is very important.	10	50	10	50	0	0	0	0	0	0
24.	Wind energy is a very important type of recyclable energy resources.	0	0	0	0	0	0	6	30	14	70
25.	I do not believe the idea of generating energy from wastes.	12	60	7	35	1	5	0	0	0	0
26.	Energy generating from resources for example solar system or water is a dream.	16	80	2	10	2	10	0	0	0	0
27.	I do not believe that recyclable energy resources contribute to energy saving.	10	50	6	30	4	20	0	0	0	0
28.	I believe that education in schools about recyclable and unrecyclable energy resources are important.	0	0	0	0	2	10	7	35	11	55
29.	I am not interested whether energy resources are recyclable or unrecyclable.	10	50	6	30	4	20	0	0	0	0
30.	In globalization process, it is important that individuals are aware of recyclable energy resources consumption.	0	0	2	10	1	5	4	20	13	65
31.	I do not see a relationship between compliance to European Union, globalization processes and use of recyclable energy resources.	7	35	6	30	6	30	1	5	0	0

32. It is important that use of recyclable energy resources is among environment protection activities.	0	0	0	0	0	0	8	40	12	60
33. Use of recyclable energy resources will eliminate harmful effects of greenhouse gases.	0	0	0	0	2	10	9	45	9	45
34. Turkey has very convenient conditions for recyclable energy resources in terms of its climate conditions and geographic condition.	0	0	0	0	2	10	10	50	8	40
35. The purpose of energy policies is to ensure the sustainability of energy systems and recyclable energy resources.	1	5	2	10	4	20	8	40	5	25
36. I believe that there is not a difference between use of recyclable energy resources and unrecyclable energy resources in terms of energy saving.	10	50	7	35	3	15	0	0	0	0
37. In on-the-job training programs. I believe that teachers should focus the importance of energy saving and energy resources, and they should create an awareness in this subject.	0	0	0	0	0	0	7	35	13	65
38. I believe that media has very important role in emphasizing the importance of recyclable energy resources.	2	10	0	0	4	20	4	20	10	50
39. Fossil fuel is a type of recyclable energy resources.	13	65	6	30	1	5	0	0	0	0

The lowest score that can be obtained from Recyclable Energy Awareness Scale, used in this research as one of the data collection tools, is 39 while the highest score is 195. It was determined that the lowest score that was obtained by teacher candidates who participated to this research was 135 while the highest score was 165. Mean score that was obtained from the scale by teacher candidates was calculated as 151,1, while standard deviation was found as 7,683. This result can be interpreted as recyclable energy awareness levels of teacher candidates are medium level.

As seen in Table 4, it was determined that in the scale, teacher candidates replied as “definitely agree” or “agree” for the items of 1, 2, 4, 6, 16, 18, 19, 20, 22 24, 28, 30, 32, 33, 34, 35, 36 and 37; moreover, they replied as “disagree” or “definitely disagree” for the items of 3, 5, 7, 8, 9, 10, 11, 12, 13, 14, 15, 17, 21, 23, 25, 26, 27, 29, 31, 36 and 39.

Table 5: t-test results of teacher candidates’ attitudes toward recyclable energy resources

	N	$\overline{X}$	***SS***	t	df	p
Pre-test	20	2,76	0,17	0,94	19	0,36
Post test	20	2,72	0,19			

In Table 5, teacher candidates’ attitudes toward recyclable energy resources pre-test mean score was found as 2,76 while post-test mean score was found as 2,72. A statistically meaningful difference between pre and post-test scores of teacher candidates’ attitudes toward recyclable energy resources was not found since results of t-test that was conducted based on those values was found as (t_{19}=0.36; p>0.05).

100% of teacher candidates replied as “Yes” for the question “Did Lego® Recyclable Energy Set helps you learn Recyclable Energy resources subject” that was asked to teacher candidates, who participated to this research, to determine their opinions and suggestions about robotic supported implementations. Some of the answers of teacher candidates as follow;

T.C-1: *"It helped so much. We did and produced by ourselves. It was a student oriented study."*
T.C-2: *"Yes, it did; it was so enjoyable to build wind turbine by ourselves."*
T.C-3: *"Yes, it did. It engaged in a very enjoyable learning opportunity."*
T.C-4: *"I did not know about the Legos that were used in the lecture, but I learned. It was so beneficial. It requires attention. It made me so happy to see that we generated energy."*
T.C-5: *"Yes, it helped so much. I and my friend designed a car working with wind panel and solar energy. The process was so enjoyable and it was the first time that I had generated energy."*
T.C-6: *"Yes, it helped so much. We designed our own solar system supported car and also we generated our own*

electricity."
Some of the answers that teacher candidates gave for the question "Do you think of using Lego® Recyclable Energy Set while teacher recyclable energy resources when you become a teacher in the future? that was asked to teacher candidates who participated to the research, as follows;

T.C-1: *"Yes, I do. It is an activity which is very practical, enjoyable and based on self-do and self-create method. It is a very good study to teacher the course to students. Any problems do not occur if sufficient time is allocated."*
T.C-2: *"I do. Because learning can be easier while spendings enjoyable time."*
T.C-3: *"I do. Learning can be more active."*
T.C-4: *"I definitely do, I think students can learn easier."*
T.C-5: *"I would like to use it but I believe its cost can be high and every school might not be able to purchase it."*
T.C-6: *"I do. Learning can be more memorable because children learn as doing by themselves. However, we might have difficulty on costs."*
T.C-7: *"I definitely do. It, not only, enhances crafting skills but also create group study opportunities as sustaining learning for subjects as doing-experiencing method."*
T.C-8: *"Yes, I do. Because, it is very enjoyable and informative. The fact that children learn the information while they enjoy can ensure the information becomes permanent."*
T.C-9: "I do. Children are the future. A good future depends on the way they are raised. World's livability, moreover, is associated with more level of use of recyclable energy resources."

Some of the answers that teacher candidates gave for the question "What kind of advantages can use of Legos in courses provide you? that was asked to teacher candidates who participated to the research, as follows;

T.C-1: "*It engages students more active. Students can find answers for their own questions. They generate their own electricity suing wind or solar system."*
T.C-2: *"When we omit time limitation, it ensures that the subject can be learnt more permanently."*
T.C-3: *"We can embody the subject that we teach abstractly."*
T.C-4: *"I ensure easier learning and the information that is learnt can become more permanent."*

Some of the answers for the question "What kind of advantages can a lecture that was organized with Legos provide students? that was asked to teacher candidates who participated to the research, as follows;

T.C-1: *"The lecture can be more enjoyable and practical. I think every teacher should use it in convenient lectures"*
T.C-2: *"I believe that Legos ensure more permanent learning for students and Legos also develop students' psychomotor skills."*
T.C-3: *"Children can learn as doing-experiencing and this ensures them to learn fast and efficient manners."*
T.C-4: *"My students would learn while enjoying."*
T.C-5: *"Students can learn while enjoying in class and can also develop their crafting skills."*

95% of teacher candidates replied as "Yes" for the question "Would you like to take a robotic based course during your undergraduate education period?" that was asked to teacher candidates who participated to the research. Some of the answers from teacher candidates are as follows;

T.C-1: *"Yes. I would develop myself in different subjects and can learn to use different material and teaching technics for my following academic life. I would like to a different teacher. Robotic education would contribute positively to my academic success. "*
T.C-2: *"I would. I would be a teacher who is more helpful for students as having information from many aspects."*
T.C-3: *"I would. I am sure that the learning that I took during a robotic based course becomes more permanent."*
T.C-4: *"I definitely would. I would like to learn while doing-and-experiencing as leaving monotone course teaching methods."*
T.C-5: *"I would, very much. Because I enjoyed very much in the implementation, I created a product while also learning and this made me so happy. "*
T.C-6/7: *"I would. We learnt while enjoying. I not only enjoyed but also learnt."*
T.C-8: *"Yes, I would. I would like to take that course not only because I would like to develop myself but also to give this course to my students."*

CONCLUSION

In this research, it was aimed to analyze the effect of robotic supported implementation on recyclable energy resources education to science teacher candidates. Before implementation process, "Robotic Pre-Questionnaire"

was applied as pre-test to measure teacher candidates' prior knowledge about Robotic subject. According to pre-test results, 55% of teacher candidates stated that they never used Lego parts before this research study. Additionally, 85% of teacher candidates stated in pre-test that they did not have information about Lego Mindstorms Robotic System. Based on these findings, majority of the teacher candidates, who participated to this research, did not use any Lego parts and did not have any information about robotic before the implementation.

Before implementation process, half of teacher candidates thought that they could learn recyclable energy resources subject using Legos. Before implementation process, 40% of teacher candidates stated that they were undecided about use of Legos in the related activities, 40% of them stated that use of Legos would be easy and 20% of them stated that they would have difficulties on using Legos. On the other hand, in post-test, 10% of teacher candidates stated that they had difficulties on using Legos, 5% of them stated that they were undecided while 85% of them stated that use of Legos was easy. This result means that majority of the teacher candidates, who stated that they never used Lego parts before this research, enhanced self-confidence and self-reliance after the implementation process.

After implementation process, all of the teacher candidates stated that they enjoyed the activities. Additionally, all of the teacher candidates stated that they are interested in use of Legos in recyclable energy resources activities.

In the research, it was determined that teacher candidates' awareness toward recyclable energy resources are medium-level. This result is similar to some of the studies in literature (Liarakou et al., 2009; Karabulut et al., 2011; Tiftikçi, 2014). Additionally, a statistically meaningful difference was not found between teacher candidates' attitudes toward recyclable energy resources for pre and post-test.

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