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Determination of the levels of elementary student teachers in putting the stages of technological design cycle into practice: A model parachute race activity

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Abstract

In this study, within the scope of Science and Technology Laboratory Applications-II Course, elementary student teachers were made to design a model parachute that can stay in the air for a time by using technological design cycle and to race these parachutes. In this regard, we introduced an activity what we call "MODEL PARACHUTE RACE" and we tried to determine levels with which elementary student teachers can put the stages of the technological-design cycle into practice. Case study method is defined as the efforts to understand the workings of a situation with unique properties within its own conditions. Since the purpose of this research was to define the levels of elementary student teachers, case study was used. The study was implemented with the attendance of 39 elementary student teachers who were currently in their second years at the Karadeniz Technical University, Fatih Faculty of Education, during the 2009-2010 spring semesters. Semi-structured interviews and diaries were used to collect data. The data obtained were analyzed by using content analysis method.

Keywords: STSE objectives, doing technological design, technological design cycle, elementary student teachers, model parachute race activity

1. Introduction

We are living in a fast moving age and depending on technology day by day. Accordingly, it is essential that students should understand the relationship between science and technology, learn to do technology, develop a set of abilities from identifying a problem to reporting and serve the abilities throughout their lives (ITEA, 2003). While students do technological design, they are expected to use the technological design activities and technological design cycle by developing solutions towards a definite problem. The design process includes identifying and defining the problem, investigation and researching it, considering a design, modeling and testing the design, dropping and trying another design if necessary, choosing final design and reporting the process (MONE, 2005; MONE, 2006 and ITEA, 2007). Doing technological design are suggested in order to gain Science-Technology-Society-Environment (STSE) objectives that are a part of "Elementary School (Grades 4-5 and 6-8) Science and Technology Teaching Curriculum" in Turkey. Through Science-Technology-Society-Environment (STSE) objectives, students are able to understand the nature of science and technology, the relationship among science, technology, society and environment and do technological design. Moreover, students realize how science and technology affect each other and how people use them to improve their quality of lives.

In the related literature, it was stated that elementary student teachers should take a formal training about technological design activities in order for 4th-and 5th- grade students to meet STSE objectives very well and effectively (Bell, 2010). We couldn't find any research about the content of this formal training. Technological design process which is advised in "Elementary School (Grades 4-5 and 6-8) Science and Technology Teaching

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Curriculum" is similar to project based science instruction tools that is used to organize project work in the science classroom (Kurnaz et al, 2005; MONE, 2005; MONE, 2006 and Colley, 2008). Fallik (2008) stated that after teachers give an experience of doing project work, they would be able to help their own students while guiding them. In addition, the researchers guides the elementary student teachers in the same way that they are expected to guide their own students. Since project based science instruction tools is similar to technological design process the method that Fallik (2008) advised can be used while the elementary student teachers are taking a formal training about technological design process. For this reason, within the scope of Science and Technology Laboratory Applications-II Course, elementary student teachers were made to design a model parachute that can stay in the air for a time by using technological design cycle and to race these parachutes. In the present research we introduced an activity what we call "MODEL PARACHUTE RACE" and we tried to determine levels with which elementary student teachers can put the stages of the technological-design cycle into practice.

1.1. "Model Parachute Race" Activity

"Model Parachute Race" Activity is aimed at training elementary student teachers for technological design activities and providing them to gain experience in technological design. In achieving this important task, elementary student teachers who were divided into seven groups of five to six students each designed a model parachute that can stay in the air for a time by using technological design cycle and to race these parachutes. The activity was implemented with the attendance of 39 elementary student teachers who were currently in their second years at the Fatih Faculty of Education of Karadeniz Technical University, Classroom Teachers Department. Moreover, it was implemented in "Science and Technology Laboratory Applications-II Course" during the 2009-2010 spring semester for 12 weeks. In this regard elementary student teachers and researchers followed the steps which are shown in Table 1.

Table 1. The process followed by doing "Model Parachute Race" Activity

	Process	
Weeks	Researchers made	Elementary Student Teachers made
1	Dividing class into small groups of five to six students each. Giving handouts on the aims of Model Parachute Race Activity and rules of the race. Giving instructions on how to do technological design. Introducing a web site at www.fenegitimi.com/parasut to announce renewals about the activity.	
2-11		Researching the principles about model parachutes, generating a number of ideas for a solution, considering a design, modeling and testing the selected design, dropping and trying another design if necessary and choosing final design
12		Reporting the process, presenting results to the whole class and racing model parachutes

2. Methodology

The activity was implemented with the attendance of 39 elementary student teachers who were currently in their second years at the Fatih Faculty of Education of Karadeniz Technical University, Classroom Teachers Department in "Science and Technology Laboratory Applications-II Course" during the 2009-2010 spring semester for 12 weeks. They divided into seven small groups of five to six students and a representative was elected for each. Case study method is defined as the efforts to understand the workings of a situation with unique properties within its own conditions (Stake, 1995). Since the purpose of this research was to define the levels of elementary student teachers' putting the stages of technological design cycle into practice, case study was used.

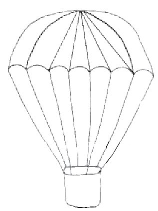
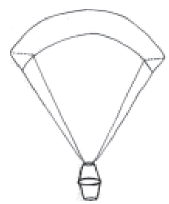
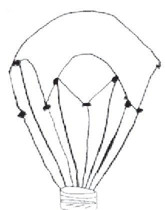
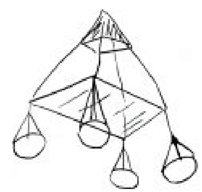
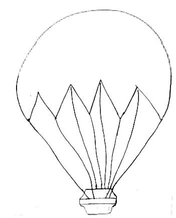
As to collect data in the research, semi-structured interviews have been made after the application with the seven representative elementary student teachers, and diaries which are written by them as they reflect on the technological design process from defining problem to presenting results have been used. There are two kinds of diary method: Investigator's diary and subject's diary (Altrichter, 1993). We used subject's diary to understand how the elementary students designed model parachute, how they put the stages of technological design cycle into practice and what difficulties they faced. In the analysis of diaries and interview data, data collection, processing, and data presentation phases (Miles and Huberman, 1994) were followed in accordance with the direction of content analysis method. Within this sense, audio recordings were transcribed; and encodings were made within the steps of technological design cycle. Using the created codes in diaries and transcribed interviews, a matrix (Table 2) was prepared in each group showing the levels of elementary student teachers in putting the stages of technological design cycle into practice.

3. Findings

Generally, groups who engaged in designing a model parachute reflected positive learning experience and used steps of technological design process properly. The levels of elementary student teachers in putting the stages of technological design cycle into practice are shown in Table 2, while they designing and building the parachute model. In the first step, they were expected to identify and define a problem. The elementary student teachers were asked to design and build a model parachute that can stay in the air for a time by using technological design cycle and to race these parachutes. In the second step, they were expected to investigate and research the problem. They researched on the internet how to build a model parachute, parachute models, examples of parachutes, physics formulas and concepts used in parachuting. The elementary student teachers in Group-1 researched factors affecting a parachute's staying in the air, Grup-7 researched length/weight rate in a parachute and Group-5 history researched of parachuting. In addition, Group-2 got assistance from Faculty of Science of Karadeniz Technical University, Physics Department about physics formulas and concepts used in parachuting, Group-3 got assistance from Trabzon Air Sports Club about making parachute and Group-6 got assistance from experienced students who made parachute before about building model a parachute.

In the third step, they were expected to generate a number of ideas for a model parachute that can stay in the air for a long time in accordance with sources which they used by researching, choose one of the ideas, consider a design and draw its picture. Grop-1, 2, 4, 6 and 7 considered final design by choosing one of the examples of parachutes or models which were researched and drew the picture of the design. Group 3 and 5 designed and tested the parachutes and then they choose the best parachute that can stay in the air for the longest time and drew its picture. In the fourth step, they were expected to model the selected design to get ready for the testing and evaluating. Table 2 shows the characteristics of the parachutes of each group. Accordingly, the surface of parachutes' shape, dimensions, areas, the strings of parachutes' length, numbers, types of tie, the attached objects' masses, the matter which is made of and shapes are presented in Table 1. In the fifth step, they were expected to test and evaluate the selected design, drop and try another design if necessary and choose final design. After all groups had tested modeled parachutes, they only changed the mass of attached objects to parachutes for deciding final design. Group 1, 2, 4, 5, and 6 inserted small stones or water into attached object to change the mass of parachutes. Group 3 and 7 tested parachutes and fixed the mass of attached objects. The mass of attached objects to the parachutes can be seen in Table 2. In the last step, they were expected to report what they did during the process and to present the results to the whole class. The elementary student teachers reported process and introduces their parachutes.

Table 2. The levels of elementary student teachers in putting the stages of technological design cycle into practice.

Steps of Technological Design Process	Group-1 (N=5)	Group-2 (N=5)	Group-3 (N=6)	Group-4 (N=5)	Group-5 (N=7)	Group-6 (N=5)	Group-7 (N=6)
1. Identifying and defining a problem	Designing and building a model parachute that can stay in the air for a time by using technological design cycle.	Designing and building a model parachute that can stay in the air for a time by using technological design cycle.	Designing and building a model parachute that can stay in the air for a time by using technological design cycle.	Designing and building a model parachute that can stay in the air for a time by using technological design cycle.	Designing and building a model parachute that can stay in the air for a time by using technological design cycle.	Designing and building a model parachute that can stay in the air for a time by using technological design cycle.	Designing and building a model parachute that can stay in the air for a time by using technological design cycle.
2. Investigating and researching the problem	● Researching on the internet; - making a parachute - parachute models - factors affecting a parachute's staying in the air. - Physics formulas used in parachuting.	● Researching on the internet; - making a parachute - examples of parachutes - Physics formulas used in parachuting. ● Getting assistance provided by Faculty of Science of Karadeniz Technical University, Physics Department.	● Researching on the internet; - making a parachute - examples of parachutes - Physics concepts used in parachuting. ● Getting assistance provided by Trabzon Air Sports Club	● Researching on the internet; - Physics formulas used in parachuting.	● Researching on the internet; - making a parachute - examples of parachutes - history of parachuting. - Physics formulas used in parachuting.	● Researching on the internet; - making a parachute - Physics concepts used in parachuting. ● Getting assistance provided by experienced students who made parachute before.	● Researching on the internet; - making a parachute - examples of parachutes - length/weight rate in a parachute - Physics concepts used in parachuting.
3. Generating a number of ideas for a solution, considering a design and drawings	Choosing between the two models called "Balloon Type" and "da Vinci Type" and drawing a picture of the choosing model which are shown below.	Choosing one of the examples of parachutes which were researched and drawing its picture that is shown below.	They designed and tested two parachutes, then choose one of which has rectangle surface and four strings and drawing its picture that is shown below.	Being inspired by an umbrella and drawing its picture that is shown below.	Every group member designed and tested her/his own parachute. Then, they choose the best parachute that can stay in the air for the longest time and drew its picture that is shown below.	Increasing the large surface of the parachute and reducing mass of the object attached to benefit from air resistance as much as possible and drawing its picture that is shown below.	Choosing one of the examples of parachutes which were researched and drawing its picture that is shown below.
							

4. Modeling the selected design	**Surface of the parachute's**							
	Shapes:	Circle	Square	Rectangle	Circle	Circle	Two Rectangles, the big one is surrounded by a thin iron wire	Octagonal
	Dimensions:	r=32,5 cm (The radius)	d=65 cm (The sides)	L=98 cm, W=45 cm	r=25 cm (The radius)	r=40 cm (The radius)	L_1=12 cm, W_1=18 cm L_2=30 cm, W_2=45 cm	d=36 cm (The sides)
	Areas:	S=3316,25cm^2	S=3025 cm^2	S=4410 cm^2	S=1962,5 cm^2	S=5024 cm^2	S=1566 cm^2	S=6257,64 cm^2
	Strings'							
	Lengths:	125 cm	60 cm	55 cm	90 cm	50 cm	20 cm	85 cm
	Numbers:	8	4	4	8	8	4	8
	Types of tie:	Bonding	Fastening	Fastening	Fastening	Fastening	Fastening	Fastening
	Attached objects'							
	Masses:	By insertion small stones into, the mass of the object can be changed	By insertion water into, the mass of the object can be changed	100 g	By insertion water into, the mass of the object can be changed	By insertion small stones into, the mass of the object can be changed	10 g	8 g
	Matter which is made of:	Carton	Plastic	Plastic	Plastic	Aluminum Foil	Plastic	Plastic
	Shapes:	Cylinder	Cylinder	Two truncated cones fastened together	Graduated cylinder	Two Truncated Cones	Four Cones	Two Truncated Pyramid
5. Testing and evaluating the selected design, dropping and trying another design if necessary and choosing final design		Deciding to change the mass of parachute by inserting small stones into attached object. Final value of mass of attached object is 67 g.	Deciding to change the mass of parachute by inserting water into attached object. Final value of mass of attached object is 75 g.	Testing to decide the mass of attached object. Final value of mass of attached object is 100 g.	Deciding to change the mass of parachute by inserting water into attached object. Final value of mass of attached object is 85 g.	Deciding to change the mass of parachute by inserting water into attached object. Final value of mass of attached object is 10 g.	Deciding to change the mass of parachute by inserting four cones which are made of plastic into parachute. Final value of mass of attached object is 10 g.	Testing to decide the mass of attached object. Final value of mass of attached object is 15 g.
6. Reporting and presenting results		Reporting process and introducing the parachutes to the whole class.	Reporting process and introducing the parachutes to the whole class.	Reporting process and introducing the parachutes to the whole class.	Reporting process and introducing the parachutes to the whole class.	Reporting process and introducing the parachutes to the whole class.	Reporting process and introducing the parachutes to the whole class.	Reporting process and introducing the parachutes to the whole class.
RESULTS of the RACE (sn)		21,63	13,66	14,92	17,48	17,56	17,34	20,18

4. Discussion and Conclusion

It can be said that the elementary school teachers could put the stages of technological design cycle into practice in general. So, the method Fallik (2008) advised to educate teachers on project based science instruction can be used while the elementary student teachers are taking a formal training about technological design process. The elementary student teachers faced some problems while they designing and building the parachute model. In the fourth step, they changed only masses of attached object among factors affecting a parachute's staying in the air. They didn't any change other factors. So, they designed parachutes in a way that mass of attached objects can be increase or reduce easily before testing parachutes.

As a result, the elementary student teachers didn't put formulas and concepts used in parachutes into practice properly. The representative of Group-2 stated the points in the interviews that "*We got assistance from Researchers at Physics Department. They recommended us to use the formulas;* $F=k.\ A.\ V^2$ *and* $V=[m.g/k.\ A]^{1/2}$ *but we couldn't use the formulas. Instead of it, we choose one of the examples and build it.*" In addition the representative of Group-5 stated the points in the interviews that "*We researched formulas used in parachuting but we didn't know how to use them. So every group member designed and tested her/his own parachute. Then, we choose the best parachute that can stay in the air for the longest time.*" As stated above the elementary students teachers researched the factors affecting a parachute's staying in the air but they didn't use the concepts or formula. Instead they build parachutes and then they tested it, so they consider final design.

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