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AN ARGUMENTATION BASED BLACK BOX ACTIVITY EXAMPLE ABOUT TRANSFORMATION OF ENERGY IN SCIENCE AND TECHNOLOGY EDUCATION

[a]Hilal KÜÇÜK, [b]Michael SCHALLIES, [c]Ali Günay BALIM

[a] Res. Assist., Mugla University, kucuk.hilal@yahoo.com
[b]Prof. Dr., Heidelberg University of Education, schallies@ph-heidelberg.de
[c]Assoc. Prof., Dokuz Eylul University, agunay.balim@deu.edu.tr

Abstract
Argumentation draws an ascending line in contemporary teaching-learning methods. Within argumentation applications the black box activity is considered to be efficient method. In this study, the black box experiment activity was applied on the topic Transformation of Energy with grade eight elementary students in Science and Technology course. This study particularly aims at answering the questions: "How is a black box experiment activity designed in science classes?" and "What are the students' views on black box experiment activity?". The argumentation was guided by the researchers during the activity. Semi-structured interviews were carried out at the end of the activity with 26 students in order to determine their views towards the activity, to identify the deficiencies and impediments and to improve it. Descriptive analysis was used to analyze the semi-structured interviews. The results analyses showed that black box activity was considered as a meaningful making, intriguing, challenging, enjoyable and motivating activity. With a well-planned black box activity, thinking, arguing and inquiry skills can possible to easily be acquired and improved.
Keywords: Science and Technology Education, Argumentation, Black Box Activity.

INTRODUCTION

It's seen that there is now no place for approaches looking into education from positivist perspective such as behaviorism in today's science education which contemporary instruction methods and strategies are adopted. On the contrary, approaches which student centered methods, strategies and methods developed in the light of pragmatist philosophy and students act an active role in education process have become prominent. Leading of these approaches is constructivism. Constructivism which was suggested initially by scientists such as Piaget, Vygotsky, Bruner and Dewey is defined by Martin (1997) as "the notion that people build their own knowledge and their own representations of knowledge from their own experience and thought" (p. 154).

Constructivism can be handled and classified in many dimensions e.g. Certain of them are Piaget's (1955) cognitive constructivism, Von Glasersfeld's (1984) radical constructivism, Lev Vygotsky's

(1978) social constructivism, Cobern's (1993) conceptual constructivism and Tobin's (1998) sociocultural constructivism. Sociocultural theory emphasizing the social interaction in individual's development, suggested by Vygotsky, Alexander Luria and Alexei Leontiev, has especially begun to influence modern constructivist approach deeply over the last years. Therefore not only cognitive components but also society's and other people's roles have been emphasized in learning phenomenon.

In the present day, teaching methodology based on social constructivism has become popular. One of the methods recently being used in science education is 'argumentation'. Even though the term was begun to be used in 1650's, the applications leaned to a previous history. Philosophers such as Aristotle, Socrates and Plato used argumentation in scientific sessions as to state their ideas, present their arguments and discuss the arguments' acceptabilities.

Argumentation, realized through supporting the presented claims with appropriate data and warrants, has been accepted day after day as one of the main methods in science education. Conceptual understanding levels, social and inquiry skills of students can be developed by the help of the method based on argumentation. A technic, which argumentation is used efficiently in, is the black box activity.

Black Box Activity

Mysteries and curiosities have held their grip on human imagination and contributed to the accomplishments of many great scientists. Over 60 years ago, Einstein stated that the most beautiful thing that can be experienced is the mysterious; it is the source of all true art and science (Rickey, 1993). If mystery is known as a request for human beings, it will be great advantage to use this appetite as an opportunity to attract students' attentions.

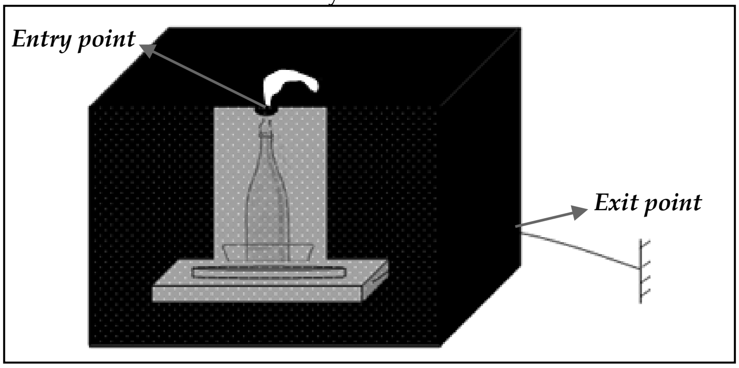
The term "black box" refers to any object that has hidden inner workings. All of Science is a black box -center of the earth, atoms, stars, cells etc.- that still waits to be opened by humanity. People seldom are able to demonstrate the reality of ideas in a physical manner (Rickey, 1993). Black box activity is an activity in inferring and inductive reasoning. The black box technic allows students to question, observe, measure, communicate their ideas and use many other technics to discover the contents of the black box.

The black box activity in this study was prepared to perform with eight grade students in a science unit: Transform of Energy. According to the curriculum, the acquirements which students should gain in this subject are;

1. The students design experiments which show mechanics and electrical energy transformation into thermal energy.
2. The students state that heating matter means that matter is getting energy.

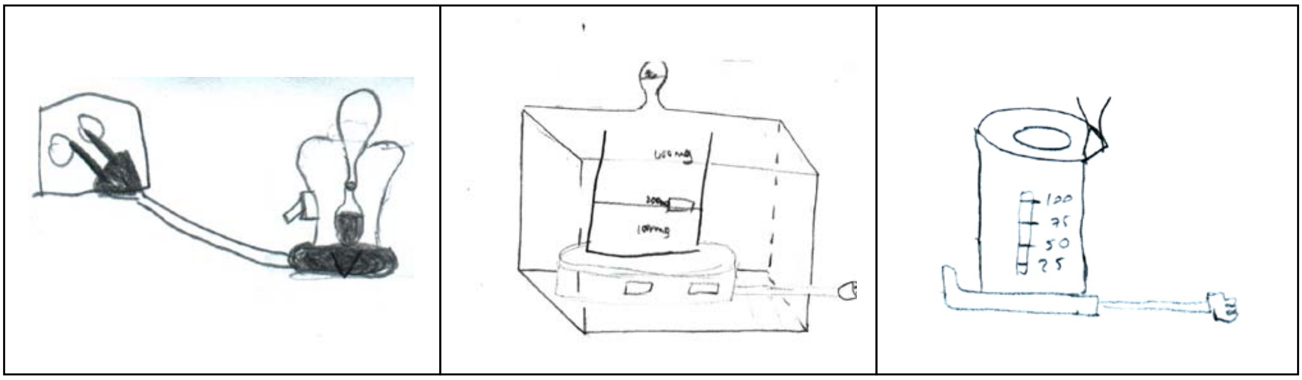
According to this activity, primarily a 30x30x30 cm3 sized box is covered with a black paper. This black form of the box provides more mystery to encourage students for making them to clarify the interior of the box. Inside the box, a system containing a heater, a beaker or a glass pot including some water, an erlenmeyer flask or a glass bottle and a balloon is placed. The black box carries an entry and an exit point. The cable of the heater comes out from the entry point, while the balloon is placed on the entry point. These entry and exit points give students some clues while they are trying to explain the model. The model of the system is showed in Picture-1.

Picture 1. Interior System of the Black Box



The science teacher firstly brings the box to the classroom and doesn't explain what the box includes. Thus before the application, the curiosities and interests of the students already increase. Afterwards the teacher shows the box to the students and therefore students touch, listen, maybe shake the box carefully and take notes of their full observations. Following the observations and taking the notes, students work in groups in order to predict which materials the box carries inside. After a small group argumentation, the teacher makes the system working by connecting the plug to the electricity, which is in the exit point of the box. The balloon starts to expand a couple of minutes later. Students observe the experiment, the observations are also taken to notes again and at the end they work in groups presenting their arguments to predict which system causes this consequence. The activity continues with argumentation. Some models which students drawed while they were trying to estimate the inner system of the box are given in Picture-2.

Picture 2. Some Examples of Students' Estimations



METHOD

In this study, the black box experiment was applied on the Transformation of Energy topic with eight grade elementary students in Science and Technology course. This study particularly focused on answering the questions: "How is a black box experiment activity designed in science classes?" and "What are the students' views on black box experiment activity?". The argumentation process was carried on with the activity. Semi-structured interviews questions, which were implemented with 26 students as to determine the views towards the activity, were submitted to experts' opinions to establish and assess the quality and validity, and the required changes were applied. Descriptive analysis was used to analyze the interviews transcription.

FINDINGS

The interviews were transcribed and subjected to descriptive analysis. Questions directed to the students were "Have you met any activity alike the black box activity before?", "What acquirements do you think you've had with the activity?", "Was there anything that you didn't like in the activity?" and "Which part of the activity affected you at the most?". The categories and sub-categories were created from the data by the three researchers during the analyzing process. Each category was named; each student was numbered and obtained data were entered in SPSS 10.0 program in accordance with the categories. The views' statistics of the students' answers to the questions are given in Table 1, Table 2, Table 3 and Table 4.

Table 1. The views' statistics of the students' answers to the question "*Have you met any activity alike the black box activity before?*"

Categories/Sub-categories		*f*	*% ~*	*Students' Expressions*	*f*	*% ~*
Positive	-Yes/I have met this before.	0	0	-		
	-Yes/I have met an activity alike this before.	2	7,7	"Not exactly the same, but a resembling one. It was like solving a puzzle."	2	7,7
Negative	-No/ I haven't met an activity like this before.	24	92,3	"I have never seen this before."	24	92,3

Table 2. The views' statistics of the students' answers to the question "What acquirements do you think you've had with the activity?"

Categories	*f*		*% ~*		
Skills	*Positive*	*No view*	*Positive*	*No view*	*Examples*
Comprehension	26	0	100	0	"I better understood the subject." "I learned transformation of energy, it was useful for me"
Argumentation skills	19	7	73,1	26,9	"The most exciting part was the debating" "It encouraged me to discuss with my friends."
Scientific Thinking	26	0	100	0	"We thought so much to figure out what was inside." "I tried to establish a connection with energy topic while I was thinking"
Observation ability	4	22	15,4	84,6	"It was required to observe carefully to find out what was happening."
Reasoning ability	5	21	19,2	80,8	"We tried to explain the experiment by estimating" "It was nice to conclude the experiment by combining our observations."
Problem solving skills	2	24	7,7	92,3	"It's like solving puzzle, we arrived the end step by step."
Curiosity	23	3	88,5	11,5	"I was really curious about what inside the box had."
İnterest	1	25	3,9	96,1	"Later time, it took my interest and I began to discuss about my observations."

Demand	4	22	15,4	84,6	"I think these activities should be realized in many lessons."
Pleasure	25	1	96,2	3,8	"Even though I was reluctant to do at first, the activity was really fun actually."

Table 3. The views' statistics of the students' answers to the question "Was there anything that you didn't like in the activity?"

Categories/Sub-categories		*f*	*% ~*	*Students' Expressions*
Positive	No/There is not a part that I didn't like.	21	80,77	"Everything was nice."
Negative	Yes/There was some parts that I didn't like.	5	19,23	"I actually got bored while we were making observation."

Table 4. The views' statistics of the students' answers to the question "Which part of the activity affected you at the most?"

Categories	*f*	*% ~*	*Students' Expressions*
Opening part (Showing the system inside)	10	39	"The time when we opened the box was really nice. I was really excited"
Experiment part	3	12	"The baloon started to expand. This part was interesting and I liked it most."
Argumentation part	13	50	"The part where we were having debate with our friends was really exciting. We really got closer to the right answer." "Everyone presented their ideas, this speeded up the debate. I liked it."

The results of the study showed that most of the students hadn't met an activity before similar to black box. All of the students thought that the activity made them understand the subject in better way and encouraged them to think scientifically. Most of the students stated that the curiosity emotion occurred during the activity and thought that the lesson became enjoyable through this activity. Many of the students also said that the activity motivated them to argue. Some of the students also explained that the activity increased their attention and interest to the lesson. There were also views adding that activity developed their problem solving, observation and reasoning abilities. According to the answers that students replied to the last two questions, several of the students said that waiting during the observation made the process boring, while most of them told there was not a point in the activity they didn't like. While half of the students added that the opening part or the experiment part of the black box excited them most, half of the students told that the arguing on solving the box mystery appealed them at the most.

CONCLUSION AND DISCUSSION

Argumentation technics such as black box activity are good starting points to encourage students for thinking, reasoning, arguing and inferring. Black box activities can also make students imagine, surmise, develop mental models and support their creativity. It can encourage students to work as a team and improve their collaboration and communication. Besides, the students can enjoy the process searching for the solutions to solve the mystery. This dynamism in the activity also brings excitement, curiosity and interest to the lesson (Kao, Gina ve Gimm, 2006; Lederman ve Abd-El-Khalick, 2002; Özdem, 2009; Saari ve Viiri, 2003). Parallel with those, the conclusions of the study showed that argumentation based black box activity could make the science classes interesting and efficient to the students. With a good designed black box activity students can think, argue and inquire scientifically.

To succeed in a black box activity technic, the activity should be well and systematically designed and scheduled. Teacher should be a good guide and direct appropriate questions to students in this problem solving process. Teachers' creativity is also significant at this point; these activities can also be developed in many other forms.

Science includes all hypothesis and experiments to observe. But it is not a collection of fact that students must memorize. The biggest black box, nature, will be closer to students with activities that encourage students to seek, observe, reason inductively and think critically.

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