



## Work-energy principle with an educational game: Capture the energy!

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### Abstract

Game is an intelligence-building pastime based on certain rules. Every child likes to play games. For this reason, the game has been integrated into education in the form of educational games. Educational games are played for students to eliminate prejudices about not being able to learn in the science course and for personal development to progress in a healthy way. In this study, an educational game activity was designed to teach the concepts in the 'work-energy principle' topic of the 'Force and Energy' unit in the 7<sup>th</sup> grade science curriculum. In this designed game, it is planned to teach abstract concepts in the subject in a meaningful and permanent way. In the research, it was intended to obtain the views of science teachers about the game called "Catch the Energy!" and to reveal what the students who played the game learned. Within the frame of this purpose, the study was performed with the phenomenology design, which is among the qualitative research methods. The game was videotaped while being played by eight students in two teams in a private secondary school affiliated to Amasya Provincial Directorate of National Education, and three participating teachers were allowed to watch the game. The opinions obtained from the teachers through semi-structured interviews and the data obtained from the students' as written documents were analyzed by descriptive analysis. From the data obtained, it was concluded that the designed educational game contributed to the students to learn the abstract concepts in the related subject in a meaningful way and that the game met the outcome. At the result of the study, educators were given suggestions such as developing games suitable for the learning outcomes in science teaching and enriching the teaching.

**Keywords:** Educational game, science teaching, work-energy principle

### Introduction

In formal education, science is the course that will enable students to establish a relationship with daily life and find solutions to the events they encounter. The science course provides skills such as lifelong learning skills, scientific process skills, and critical thinking skills (MoNE, 2018). Middle school students are expected to transition to the abstract operations period (Atasoy & Ertürk, 2008). In this transition period, if the student fails to achieve this in the learning process, permanent learning can be realized by using active learning techniques. Play, one of the active learning techniques, is an entertainment method that develops talent and intelligence and has certain rules. Every child loves to play games. It is the bridge between the child and the world. For this reason, play is integrated into education through educational games. In the science course, educational games are played to eliminate prejudices, to gain science skills and to ensure healthy personal development (Karamustafaoglu & Kaya, 2013; Tut, 2018; Karamustafaoglu & Coşgun, 2021).

The concepts of force, work and energy, which we frequently encounter and experience in daily life, are difficult concepts for students to understand. Science lessons play an important role in bringing science to life for students. Boyraz and Serin (2015) state that motion is also a science term and that children have to experience the rules of physics as long as they are moving and that they need to apply force to the ground in order to reach the height they want, thus children can make sense of abstract science concepts.

In this study, it was intended to obtain the opinions of science teachers and the students who played the game about the "Catch the Energy!" game designed to teach 7<sup>th</sup> grade students the subject of work and energy relationship in the unit of force and energy by entertaining them. In terms of this purpose, responses were sought to the following sub-problems. Science teachers'

1. What are their opinions about educational games?

2. What are their opinions about which skills educational games provide to students?
3. What are their opinions about the designed game named "Grab the Energy!"?
4. What are their opinions about using educational games in their lessons and designing educational games? and
5. How do students make sense of the tracks in the designed game?

## Methodology

### Research model

In the study, a phenomenological design, an approach to qualitative research, was utilized. The phenomenological design emphasizes individual experiences and social interactions to comprehensively understand real-world situations, events, or processes (Creswell, 2013; Larsen & Adu, 2021).

### Study Group

The working group of 8 students, including half of them were male, studying in a private secondary school in Amasya province and 3 science teachers who were actively working as of the 2022-2023 academic year and who voluntarily participated among the teachers with whom the purpose of the study was shared. Typical case sampling, one of the purposive sampling methods, was used in the selection of the students, and this method is used to illuminate the unusual (Patton, 2018). The identities of the teachers, two of whom were male, were kept confidential and coded as T1, T2 and T3. Table 1 shows the demographic information of the teachers.

**Table 1.** Demographic Information of Science Teachers

Code	Gender	Professional Experience	Graduation	Age	Place of Duty
T1	Female	8	Science	32	Amasya
T2	Male	3	Science	27	Tokat
T3	Male	14	Science	38	Amasya

### Data collection

First, after obtaining the necessary permissions, eight 7<sup>th</sup> grade students studying in a private secondary school were made to play the game named "Capture the Energy" as shown in the Appendix and the game was recorded. The video recordings of the game were shown to the participant teachers and interviews lasting approximately 15-20 minutes were conducted with them to learn their opinions about the game. In these interviews, the questions asked to them as seen in the sub-problems of the research were prepared in a semi-structured interview format. Then, the students who played the game were asked to complete the sentences that were given clues with what the students understood from the tracks in the game.

### Data Analysis

Descriptive analysis was used to analyze the data collected in the study. The aim of descriptive analysis is to group the data according to themes and interpret the study in a way that the reader can understand within the framework of themes (Harding, 2018; Özmen & Karamustafaoğlu, 2019). The findings from the interviews conducted in the study are summarized in tables and direct quotations from the teachers' opinions are presented.

### Findings

In this section, the findings obtained from the interviews are presented in the order of the sub-problems. While the common aspects of the answers received from the teachers are given as themes in the tables, one-to-one quotations from some of the teachers' answers are also presented.

**Table 2.** Teachers' Views on Educational Games

Theme	Category
Educational game	Useful
	Intriguing
	Exciting

Science teachers stated that when educational games are used correctly, they increase permanent learning, are interesting, fun and useful. Teacher coded T3 also: *"In fact, educational games are a method that not only children but also people of all ages can learn willingly, have fun and prefer."*

**Table 3.** Teachers' Opinions About the Skills That Educational Games Provide to Students

Theme	Category
Skills	Psychomotor
	Cognitive
	Affective

All science teachers stated that educational games improve children's skills in all the learning domains. Some quotations from the statements of T1 and T3 coded teachers on this subject are as follows. T1: *"... some games may be aimed at solving a problem or generating new ideas, while others may be aimed directly at measuring children's attention. In other words, the skills may differ from game to game, the skills it provides may vary according to the structure of the game, but I believe that if it is to be used in education, it should be included in these three learning domains as much as possible..."* and T3: *"Games require patience, being a team, self-confidence, using problem-solving skills, as well as being exploratory, competing within the time limit and being the closest to the truth while doing all these. It also enables them to express themselves better, in other words, to develop their social skills..."*

**Table 4.** Teachers' Opinions About the Designed Game

Theme	Category
Capture the energy	Track game
	Difficult to control
	Understandable

Science teachers stated that the rules of the game were at an understandable level, but since it was a track game, the teacher would have difficulty in the implementation phase. Science teacher coded T1 also: *"... teachers may have difficulty in controlling students. Because while the students are competing, the pontoons may tip over, the balls may go to one side, so there may be some confusion."*

**Table 5.** Teachers' Opinions on Using Educational Games in Their Lessons and Designing Educational Games

Theme	Category
Design and use in lessons	Development of skills
	Permanent learning

Science teachers stated that abstract concepts such as energy and work, which are difficult to understand, can be learned more permanently through educational games. teacher coded T2 also: *"...in other words, the child should not only throw a ball, but he should also solve the puzzle when necessary, and when necessary, he should cognitively pattern the result of the game in his own mind. I would organize a game in this way, I would organize a game in which there are many skills that address learning domains."*

**Table 6.** Student Answers for Track (N=8)

Track no	Student answers	f
1	Work is related to force and distance.	8
	Work reduces as potential energy decreases.	4
2	Work decreases as potential energy decreases.	3
	Work slows down as potential energy decreases.	1
3	The ball moving with force gets speed.	5
	The ball moving with force gets energy.	3
4	Work is done with both potential energy and kinetic energy.	4
	Work is done with both rest energy and accelerated energy.	2
	Work is done with both strong energy and focused energy.	2
	Work is done with both strong energy and kinetic energy.	1

According to the student responses, it was thought that the designed educational game met the learning outcomes and generally helped to understand abstract concepts such as work and energy.

### Results, Conclusions and Recommendations

As a result of the research, when the opinions of science teachers about the use of educational games in lessons were examined, all teachers stated that educational games were instructive. They stated that the lessons were funny, attention-grabbing, and the subjects were easier and more permanent with the game method. Similar to this study, Hanbaba and Bektaş (2011) stated that the game makes the lesson enjoyable, concretizes abstract knowledge, contributes to student development, and increases students' learning motivation. Karamustafaoğlu, Pazar, and Karamustafaoğlu (2018) reported in their study that teaching using educational games facilitates learning and positively affects permanent learning. In addition, it was determined that similar results were reached in publications on various science subjects in the relevant literature (Alan, 2016; Bayat, Kılıçaslan & Şentürk, 2014; Beker Baş & Karamustafaoğlu, 2020; Çayır & Karamustafaoğlu, 2019; Çiftçiabaşı & Karamustafaoğlu, 2019; Karamustafaoğlu & Baran, 2020; Şentürk, 2020).

It was understood that the implemented game contributed to many factors such as students working in harmony with a team spirit, forming groups according to their own wishes, guessing, and quick thinking. In addition, according to science teachers, educational games contribute to the development of students' skills in psychomotor, affective, and cognitive learning domains. According to the students, it was concluded that the designed educational game contributed to the understanding of abstract concepts of work and energy.

In conclusion, the following recommendations are presented for those who will conduct similar research.

- Opinions about the designed educational game can be obtained from a larger sample group.
- The designed educational game can be realized with experimental method and its success in teaching can be measured.
- Since the designed game is difficult to control, students may not be asked to compete against time.
- Since the designed game is held in an indoor sports hall, the tracks can be prepared using different materials.
- Similar games can be designed in different science subjects by taking into account the skill development of students in different learning domains.

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### Appendix: Designed Game

Course Title / Grade	: Science / 7
Unit / Subject	: Force and Energy / Work and Energy
Outcomes	: F.7.3.2.1. Explain that physical work is related to the force applied and the path taken. F.7.3.2.2. Classifies energy as kinetic and potential energy by associating it with the concept of work.
Name of the game	: Capture the energy!
Place where the game is played	: Indoor sports hall
Game Type / Number of Students	: Group Game / 2 groups (total 8 students)
Materials	: bowling balls, bowling pins, bouncy ball, 3 balls each, string

#### Rules of the Game:

1. The game is a track game that each student in the groups can play in turn.
2. The number of students who will play the game may vary according to the class size and the time allocated to play the game.
3. The game can be played in the classroom and in the garden. Two of the game tracks should be set up.
4. Students compete against time in the game. +4 points are added to the player who finishes early.
5. After completing the first track, the first student in the group is asked to write the result of the track on a piece of paper and throw it into the ballot box.
6. Each student in the group completes the first track in turn, writes the result on the paper, throws it in the ballot box and moves on to the second track.
7. The one who writes the correct sentence is the winner of that track.
8. The group that wins more tracks than the other wins the game.

#### How to Play the Game:

1. First, players and groups are identified. Students are informed about the rules of the game.
2. The game starts with the teacher's signal.
3. On the first track, students are asked to knock down the pins with a bowling ball. The first student who knocks down the pins writes what he/she understands about what he/she has done on the given paper, throws it into the chest and passes to the second track. Meanwhile, the second student plays the first track.
4. In the second track, he/she is expected to drop the ball from a certain height, to realize that he/she cannot pass over the ropes placed at certain distances, and to establish the relationship between the work done and potential energy.
5. In the third track, he/she hits the standing balls with another ball and makes them move and is expected to associate the work done here with kinetic energy.
6. In the fourth track, the student is expected to drop a ball on the table by applying force with another ball.
7. At the end of each track, the student writes what he/she understands from the track on the papers with the clues written on them and throws them into the box.
8. The group with the most correct sentences wins the game.

Below are the sentences written on the papers given to the students. We ask our students to discover what is meant to be explained on the tracks, that is, the words indicated in red, and write them on papers.

- Work is related to **the force applied and the distance traveled** (Track 1)
- As the **potential energy** decreases, the work **decreases** (Track 2)
- The ball moving **with force** gets **kinetic energy** (Track 3)
- Work is done with both **potential energy** and **kinetic energy** (Track 4)

Game Chart

Box 1	Box 2
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Table

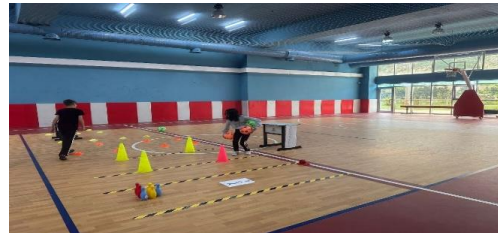
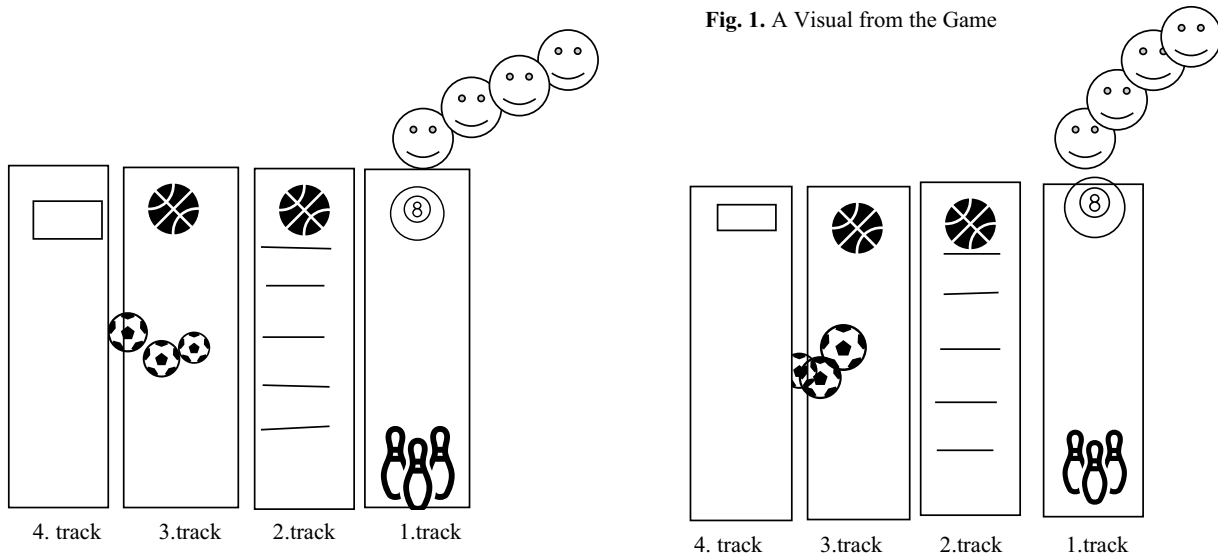


Fig. 1. A Visual from the Game



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