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Conceptions of students about renewable energy sources: a need to teach based on contextual approaches

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Abstract

Renewable energy sources are one of the main topics not only in scientific researches but also in daily life. In this study, it is aimed to investigate Turkish primary and secondary students' knowledge about the renewable energy sources. 107 primary and secondary school students participated in the study. Open-ended questions are used to determine students' knowledge about the topic. Students' answers were analyzed using descriptive analysis technique. It is revealed that there were major differences in students' answers according to grades. In addition, these answers were depended on their conceptual frameworks. These frameworks can be classified into two categories as daily life and school context. It is hoped that this study would contribute both to understand students' knowledge related to this topic and to teach energy sources based on contextual approaches.

Keywords: Renewable enery sources; energy sources; education; contextual teaching; students' knowledge.

1. Introduction

Energy, which is essential for all forms of life, is a concept of daily life. This concept is used to express many variations of situations in daily life. For example; if someone is exhausted, he/she could say my energy is depleted. In physics, so many variations of use of the word energy can be summarized as the amount of work that can be performed by a force. Different forms of energy, such as sound, light, thermal, electromagnetic, potential, kinetic, and gravitational energy, can be transformed into each other's form. But the total energy can not change and remains the same. These forms of energy are sourced by different kinds of matter or situations. Our lives mainly depend on those energy sources. In addition, developing technology and increasing population demands vast energy sources for consuming (Kandpal & Garg, 1999; Jennings & Lund, 2001; Dovi et al., 2009; Chaar & Lamont, 2010).

In general, energy sources can be categorized into two types that are renewable and non-renewable energy sources. Today, in our struggle to increase power supplies to meet the needs of modern life we have begun to cause irreversible damages to the biosphere, which supports all forms of life. In this process, serious air pollution problems

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have been caused by using non-renewable energy sources. Global warming now appears to be increased as a result of the enhanced greenhouse effect.

In this context, physics education plays a significant role in our daily life. Hence, the importance and relevance of establishing real-life connections to physics is frequently cited in the literature (Enghag, Gustafsson & Jonsson, 2009; Park, 2004; Rennie & Parker, 1996; Stinner, 1994; Whitelegg & Parry, 1999; Wilkinson, 1999). Turkey is a developing country and there are significant and rapid changes and developments in its educational system. Consequently, as being an integral part of the educational system, school curricula have been changed recently. Meanwhile, physics curriculum has renewed in a way that physics concepts should be taught through context-based approaches.

Tanriverdi (2009) analyzed new Turkish primary school curriculum in terms of sustainable environmental education. She found that learning outcomes about renewable energy sources were only in science lessons and were in a small scale. She criticized that only sun and geothermal energy sources are provided as examples of renewable energy sources. In addition, when we analyzed the Turkish secondary education, it is revealed that the geography and the physics curricula include some content and learning outcomes about energy sources in a small scale.

According to Carr and Kirkwood (1988), although renewable energy resources may be an important topic in school science, it should be taught carefully. Furthermore, they supposed that students use a very much more context-specific view. For this reason, in case of theoretical, context-free and mainly quantitative teaching, their misconceptions and difficulties will be continue to exist. On the other hand, it is hoped that context-rich scenarios and problems provide a milieu and a confrontation with their thoughts to discuss different points of view and to apply their knowledge to practical situations so that they better comprehend the energy concepts.

The purpose of the study is to investigate Turkish primary and secondary students' knowledge about the renewable energy sources. The following research questions are tried to answer in the study:

1. What kinds of energy sources do students know?
2. What kinds of renewable energy sources do students know?
3. How the knowledge about types of energy sources are differ according to grade?

2. Method

2.1. Participants

The participants consisted of 107 randomly selected primary and secondary school students in Turkey. Of all participants, 21 (19.6%) were in 4-5 grades, 36 (33.7%) were in 6-8 grades and 50 (46.7%) were in 9-12 grades. In Turkey, primary education, as a compulsory education, is intended for pupils aged 6 to 14 years. It is divided into two stages. The first stage consists of grades 1-5, and the second stage consists of grades 6-8. Secondary education (lycee) consists of grades 9-12. School curricula, which are designed and implemented by the Ministry of National Education, are the same for all types of school. Basic concepts related to energy are provided within grades 4 to 5.

2.2. Instrument and data analysis

The purpose-designed instrument is developed to include open-ended questions so that students can explain their knowledge not in limited. The open-ended questions related to the energy are the following: a) What kinds of energy sources do you know?; b) What kinds of energy sources are renewable?; and c) What is the main energy source that is required to sustain life on the Earth? In this study, students' answers to the questions were analyzed using descriptive analysis technique.

3. Results and discussion

As seen in Table 1, when the total frequency of energy sources is examined, it is seen that 75.7% of students accepted the sun as an energy source in the first order. Water (34.6%), coal (28.0%), electricity (25.2%), petrol (23.4%), wood (20.6%), wind (20.6%) and food (19.6%) are expressed as the other common known energy sources. A general look to these results says that students know some energy sources, but since "electricity" is not an energy

source but a phenomena resulting from the presence and flow of electric charge, and can not be described as energy source, they wrongly held electricity as an energy sources This misconception changed according to grades as fallows: for grades 4-5., 57.1%; for grades 6-8, 22.2%; and for grades 9-12, 14%.

Table 1. Frequencies of types of energy sources

	Grades 4-5 (n=21)		Grades 6-8 (n=36)		Grades 9-12 (n=50)		Total (n=107)	
Energy Source	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***
Sun	5	23.8	31	86.1	45	90.0	81	75.7
Water	13	61.9	12	33.3	12	24.0	37	34.6
Coal	20	95.2	2	5.6	8	16.0	30	28.0
Electricity	12	57.1	8	22.2	7	14.0	27	25.2
Petrol	13	61.9	5	13.9	7	14.0	25	23.4
Wood	16	76.2	2	5.6	4	8.0	22	20.6
Wind	0	0.0	8	22.2	14	28.0	22	20.6
Food	2	9.5	10	27.8	9	18.0	21	19.6
Heat Energy	0	0.0	5	13.9	8	16.0	13	12.1
Light Energy	0	0.0	5	13.9	7	14.0	12	11.2
Nuclear	0	0.0	3	8.3	8	16.0	11	10.3
Dump	1	4.8	4	11.1	5	10.0	10	9.3
Electric Bulb	3	14.3	4	11.1	2	4.0	9	8.4
Natural Gas	0	0.0	0	0.0	6	12.0	6	5.6

Another important finding related to types of energy sources according to grades is the great differences between grades 4-5 and the other grades in some of their ratings. Although grade 4-5 students expressed many energy sources (coal 95.2%, wood 76.2%, petrol 61.9%, and water 61.9%) that are used in daily life, the other grade students frequently expressed the sun as the main energy source but they did not give so much importance to the other energy sources.

As seen in Table 2, when students' answers about renewable energy sources are examined, it is seen that battery (32.7%) is more frequently expressed than the other sources. Battery is a container of electrical energy, but it can not be accepted as a renewable energy source. This is another misconception of students. On the other hand, some students empty this question (24.3%). As a result, it can be said that some students do not know renewable energy sources definitely and some have misconceptions related to these concepts.

Table 2. Frequencies of types of renewable energy sources

	Grades 4-5 (n=21)		Grades 6-8 (n=36)		Grades 9-12 (n=50)		Total (n=107)	
Renewable Energy Sources	***f***	***%***	***f***	***%***	***f***	***%***	***f***	***%***
Battery	10	47.6	3	8.3	22	44.0	35	32.7
No answer	0	0.0	19	52.8	7	14.0	26	24.3
Sun	1	4.8	4	11.1	20	40.0	25	23.4
Water	9	42.9	1	2.8	8	16.0	18	16.8
Electricity	7	33.3	6	16.7	0	0.0	13	12.1
Wind	0	0.0	4	11.1	9	18.0	13	12.1
Food	5	23.8	1	2.8	2	4.0	8	7.5

As seen in Table 2, most of the students rated battery and sun as renewable energy supplies, which are frequently used daily life concepts. It is revealed that students have some difficulties to explain renewable energy sources and that they do not clearly understand these energy concepts. Similarly, Leggett (2003) stated that many participants in her study were hesitant and uncomfortable with the energy concept "renewable". On the other hand, the participants successfully discussed their life experiences and some social and technical dimensions related to these kinds of concepts. Therefore, it can be said that students start from real-life contexts in their thinking about energy. Hence, when constructing and developing energy concepts, everyday contexts should be taken into consideration and the concepts should be constructed based on meaningful and practical activities in appropriate domestic and familiar contexts. Physics teachers can find some useful resources to support them in using those kinds of contexts (see for example, King & Kennett, 2002).

Generally, most of the students regarded the sun (90.7%) as the main energy source to sustain life on the earth. In addition, this high perception about the sun is almost the same within the grades (see Table-3). Moreover, as being daily life concepts, air (42.9%) and water (38.1%) were regarded as the second and the third energy sources to sustain life on the earth by grades 4-5. On the other hand, this perception decreases as the grade levels increases.

Table 3. Frequencies as related to the main energy source to sustain life on the earth

Main Energy Source	Grades 4-5 (n=21)		Grades 6-8 (n=36)		Grades 9-12 (n=50)		Total (n=107)	
	f	*%*	*f*	*%*	*f*	*%*	*f*	*%*
Sun	17	81.0	30	83.3	50	100.0	97	90.7
Water	8	38.1	2	5.6	1	2.0	11	10.3
Air	9	42.9	0	0.0	1	2.0	10	9.3
Heat Energy	0	0.0	5	13.9	5	10.0	10	9.3
Biomass	5	23.8	0	0.0	0	0.0	5	4.7
Light Energy	0	0.0	3	8.3	2	4.0	5	4.7
Food	3	14.3	0	0.0	0	0.0	3	2.8

When the results related to the Table 1 and Table 3 are interpreted together, it can be deduced that students' conceptual frameworks are mainly affected by their surroundings. Then, it may be possible to categorize these effects which are stem from their surrounding as *daily life context* and *school context*. As can be seen from the differences between grades 4-5 and grades 9-12 related to their energy concepts, conceptual frameworks of grades 4-5 are mainly aroused from the daily life context. On the contrary, conceptual frameworks of grades 9-12 are mainly aroused from school contexts.

4. Conclusion and Recommendation

This study not only reveals the need for contextualizing energy concepts in school curricula, but it also makes a small contribution to raising some awareness regarding environmental issues.

Much more learning outcomes related to renewable energy sources must be added to the primary and secondary education curricula with environmental issues, which could be faced in daily life context. Therefore, from grade 4 to grade 12 students will be interested in social and economical problems that include efficient energy uses. Meanwhile, students would have an opportunity to combine daily life context with school context.

Through practical applications and experiential learning, and further discussions, reflections and authentic assessments in which students conduct contextual and real-life based projects and performance works, students would be consciously aware of alternative energy supplies and their environments. Thus, they would study in a contextual manner and would better understand those concepts and related environmental and societal issues. In addition, they would recognize that everyday phenomenon and energy concepts are strongly related with each other.

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