*Energy Education Science and Technology Part B: Social and Educational Studies*
**2012** Volume (issue) **4(3):** 1829-1840

# Awareness and misconceptions of high school students about renewable energy resources and applications: Turkey case

**Hasan Said Tortop***

*Zonguldak Karaelmas University, Faculty of Education, Zonguldak*

Received: 23 July 2011; accepted: 21 September 2011

**Abstract**

Turkey is the one of the countries in the world which has potential of renewable energy resource because of its geographical position. However, being usage of renewable energy resources and applications (RERAs) is low, it shows that awareness and consciousness of REARs is very low too. Education must play a key role in growing out of an energy culture at a nationwide scale, which means developing an energy awareness of environmental, scientifically and economical respects. Energy awareness is a concept that includes multiple aspects and this situation closely related to sustainable development. In this study high school students' awareness of REARs has been investigated and data was obtained from interview forms of 127 students who have been attending different high school in Isparta city. As the results of this study it has been found out that high school students' awareness of RERAs is very low, they have lots of misconceptions about RERAs, they mostly wouldn't have a career plan about RERAs and they mostly are not aware of research centre about RERAs at the university, which is in the city they live. High school students being keen on arranging field trip to research centre related to RERAs at the university give us signs about renewable energy education.

*Keywords***:** Renewable energy education, awareness, misconception.


## 1. Introduction

Renewable energy resources (such as; hydroelectric, solar, biomass, geothermal, wind, ocean and bio energy) are inexhaustible and offer many environmental profits over conventional energy sources. Each type of renewable energy also has its own special advantages that make it uniquely appropriate to certain applications which PV Technologies, solar heater, biogas technology and so on [1-3]. RERAs experiences have demonstrated many advantages and benefits of using such simple and cheap technologies.

*Corresponding author. Tel.: +90-372-323-3874/115; fax: +90-373-323-8693.
*E-mail address*: hasansaid@yahoo.com (H. S. Tortop).

Turkey is a country, which has high potential renewable energy resources, but usage of RERAs is very low [2, 4-6]. However, nowadays increasing of strategies and policy about using RERAs more efficiently [3, 7-10]. It is important that education is the key factor constituting awareness and consciousness about RERAs [6, 11-18]. The fact that renewable energy education is related to environmental education increases that importance. However, many researchers stressed lack of studies and activities related to environmental education [19-21]. Inadequacy of environmental education and using ineffective teaching strategies may cause students and even pre-service teachers to have many misconceptions about RERAs [22-25]. Clearing off misconceptions is very important issue or problem at education. It stated that to determine students' misconceptions about any topic, several techniques such as diagnostic tests, interviews and other methods are primarily task [26-30]. Teachers should use more effective teaching strategies to prevent misconceptions and promote conceptual change [31, 32]. In Turkey, it has been done (achieved) by curriculum changes in 1991, 1994 and lastly in 2004 related to better education about environment and accordingly RERAs, which have utmost importance for future of the earth we live [33, 34].

New high school curriculums include parts of renewable energy education. This new curriculum aimed to teach intensively about RERAs and relation of environment topics (such as, Physics curriculum 9th grade, 4th Unit: Energy; importance of renewable energy, difference of fossil fuel and renewable energy and renewable energy saving, 11th grade 6th Unit: From Stars to Quasar; solar energy, solar radiation and solar collector. Chemistry curriculum 9th grade 5th Unit: Chemistry in Our Life; ecology friend alternative energy resource, 12th grade 1th Unit: Chemistry of Elements; hydrogen energy and its importance. Biology curriculum 9th grade 3th Unit: Conscious Person Liveable Environment; environmental issues and relationship renewable energy [21, 34, 35].

However, Nartgün et al. [36] stated that students ignored some important activities and topics that reason it has been not parallel designed educational quality at school with content of entering high school exam. Since high school education is the period which shapes clearly career and plans of students, RERAs education is important in view of awareness of RERAs [17, 35].

There have been insufficient studies about renewable energy awareness [36, 18], and there have been limited number of studies probing students' understanding and misconceptions on RERAs in Turkey. And also in view of secondary education period investigations of student's awareness of RERAs are inadequate.

The aim of this study is determining high school students' awareness and misconceptions about renewable energy and applications.

## 2. Methodology

This study was conducted with the case study research design. Case study, which is one of the qualitative research methods, was used in the study, embedded single-case, which is case study design, was selected for research design [37]. The purpose-designed instrument is developed to include open-ended questions. The open-ended questions were constructed to identify any misconceptions as perceived by the students and to determine knowledge level of renewable energy resource and applications.

*2. 1. Sample*

The sample of the study comprises 127 high school students in a public and private high school located in the city centre of Isparta. Demographic structure of students was show as follows Table 1.

**Table 1. Demographic Structure of Students**

| | *f* | *%* |
|---|---|---|
| Gender (*N*=127) | | |
| Male | 58 | 45.7 |
| Female | 69 | 54.3 |
| Teaching school type (*N*=127) | | |
| Public school | | |
| Gonen Anatolian Teacher Training High School | 15 | 11.8 |
| Kacikoc Anatolian High School | 15 | 11.8 |
| Isparta Anatolian High School | 19 | 15.0 |
| Isparta Imam-Hatip High School | 5 | 3.9 |
| Gazi High School | 12 | 9.4 |
| Suleyman Demirel Science High School | 5 | 3.9 |
| Gulkent Anatolian high School | 17 | 13.4 |
| Isparta Anatolian Teacher Training High School | 11 | 8.7 |
| Mustafa Gurkan Anatolian High School | 17 | 13.4 |
| Private school | | |
| Bedri Ayhan Anatolian High School | 11 | 8.7 |
| Grade (*N*=127) | | |
| 9th grade | 51 | 40.2 |
| 10th grade | 37 | 29.1 |
| 11th grade | 39 | 30.7 |
| Renewable Energy Related Courses Grade | *M* | *sd* |
| Physics grade | 72.91 | 14.95 |
| Chemistry grade | 73.71 | 14.62 |
| Biology grade | 77.52 | 14.64 |
| Father Educational Level | *f* | *%* |
| Primary school | 32 | 25,2 |
| High school | 37 | 29,1 |
| Associate degree | 10 | 7,9 |
| Graduated | 15 | 11,8 |
| Post-graduated | 32 | 25,2 |
| Total | 126 | 99,2 |
| Missing | 1 | 0,8 |
| Mother Educational Level | | |
| Primary school | 56 | 44,1 |
| High school | 41 | 32,3 |
| Associate degree | 7 | 5,5 |
| Graduated | 8 | 6,3 |
| Post-graduated | 14 | 11,0 |
| Total | 126 | 99,2 |
| Missing | 1 | 0,8 |
| Socio-Economic Level | | |
| Sub 750 TL | 13 | 10,2 |
| 750-1500 TL | 40 | 31,5 |
| 1500-3000 TL | 53 | 41,7 |
| 3000 TL + | 21 | 16.5 |
| Total | 127 | 100.0 |

### *2. 2. Data collection*

In this study an interview form comprising open-ended questions related to renewable energy and technology were used to collect data. The contents of this form were determined by considering the current physics and science curriculum and textbooks for ninth, tenth and eleventh grade. The data collection tools were also reviewed by three researchers studying on physics and science education, so that the validity and the reliability of them were increased.

The interview form used in this study is comprised of four sections which are assigned to investigate students' understanding and to determine their awareness and knowledge level of renewable energy and technology. First section is RERAs Knowledge, second section is The Relationship between RERAs and Environment, third section is The RERAs and Career. All students in the sample answered the form. The questions in data collection tools to be investigated by them are summarized in Table 2.

**Table 2. Data collection tools and sections and example of some open ended questions**

| |
|---|
| Section 1. The RERAs Knowledge |
| Q2: Please explain how do solar collectors on the roofs of houses produce hot water? |
| Q6: Which resources contributed more your knowledge of renewable energy and technology? If you needed more knowledge of this subeject, which resources would you apply? |
| Q8: Are you informed of Resource and Application for Renewable Energy Centre (RAREC) at Suleyman Demirel University (SDU)? If yes, where did you get this information? Would you like to attend an excursion to there? What would you expect this excursion? |
| Section 2. The Relationship between RERAs and Environment |
| Q10. What kind of relation exists between renewable energy & technologies and environment? |
| Q11. If you are responsible for executing energy politics of our country, what would you do? Could you explain your attempts? |
| Section 3. The RERAs and Career |
| Q14. Would you think of having a career on renewable energy resources and technology? If yes, why? What made you have this idea? |

### *2. 3. Process*

The research was conducted in the spring term of 2010-2011. After the instruction of the subject of renewable energy and technology, the test was administered to the sample. Student responses test items were analyzed in detail to elicit students' understanding and misconceptions about renewable energy and technology and relationship between renewable energy and technology and environment. In analyzing open-ended test items, firstly student responses were examined thematically and the following criteria were developed for classification: sound understanding, partial understanding, and partial understanding with specific misconception, specific misconception, and no response/no understanding. These criteria are similar to those used by Abraham et al. [38], Calik [39], Sendur et al., [40] and Unal et al. [41]. Descriptions of these criteria are as follows:

Sound Understanding: Responses that include all components of the validated response

Partial Understanding: Responses that include at least one of the components of the validated response, but not all.

Partial Understanding with Specific Misconception: Responses that show partial understanding of the concepts by students but that also contain misconception.

Specific Misconception: Responses that include incorrect or illogical information.

No Response/No Understanding: Responses that include reputations of a part or full of the question, irrelevant ideas, and no answer.

*2. 3. Data analysis*

In this study, students' answers to the open-ended questions were analyzed using content analysis technique [37].

## 3. Findings

*3.1. Findings from the open-ended test items*

Student responses in the specified categories to each open-ended test item are elaborated rigorously and presented in this section. The percentages of student responses in each category for all open-ended test items are shown in Table 3.

**Table 3. The percentages of student responses in Section 1 for the test items**

| Test Items | SU (%) | PU (%) | SM (%) | NR/NU (%) |
|---|---|---|---|---|
| **Q1** | 30 | 31 | 2 | 35 |
| **Q2** | 14 | 31 | 15 | 39 |
| **Q3** | 5 | 6 | 18 | 70 |
| **Q4** | 10 | 35 | 15 | 40 |
| **Q5** | 7 | 14 | 8 | 70 |
| **Q6** | 13 | 24 | 7 | 56 |
| **Q7** | 14 | 46 | 1 | 38 |

**SU:** Sound Understanding, **PU**: Partial Understanding, **SM**: Specific Misconception, **NR/NU**: No Response/No Understanding

**Q1:** What are fossil fuels, renewable energy (RE), renewable resources and technologies? What's your opinion about them?
**Q2:** Please explain how do solar collectors on the roofs of houses produce hot water?
**Q3:** How do solar batteries generate electricity? What are they made from?
**Q4:** How do hydro-electric power plants at the dams generate electricity?
**Q5:** How is energy obtained from biogas?
**Q6:** What do you know about our country's potential of RE resources? Explain, please.
**Q7:** What kind of relation exists between renewable energy resources technologies and saving the environment? Explain, please.

In Table 3 revealing results of analysis data obtained from open-ended questions to evaluate awareness and knowledge level of students about RERAs, it is seen that scientifically responding rate is at the lowest level in all questions. However, it is also seen that the rate of giving no respond or wrong answers to questions stated above is at the highest level.

**Table 4. The percentages of students' responses knowledge resources of RERAs**

| | *f* | *%* |
|---|---|---|
| Knowledge Resource of RE (*N*=127) | | |
| School | 64 | 36 |
| Book | 19 | 11 |
| Magazine | 7 | 4 |
| Internet | 52 | 29 |
| Fair | 2 | 1 |
| TV | 16 | 9 |
| Friend | 1 | 0.5 |
| Newspaper | 5 | 3 |
| No answer | 13 | 7 |

As it is seen in Table 4, students' responses for knowledge resources of RERAs in terms of frequency levels are school (64), internet (52), book (19), and TV (16) respectively.

**Table 5. The percentages of student responses SDU RAREC Awareness**

| | *f* | % |
|---|---|---|
| Awareness of RAREC (*N*=127) | | |
| Informed | 116 | 91 |
| Not informed | 9 | 7 |
| No answer | 2 | 1 |
| Willingness of field trip to RAREC (*N*=127) | | |
| Informed students | | |
| Do want | 82 | 65 |
| Don't want | 9 | 7 |
| Unwritten | 25 | 20 |
| Not informed students | | |
| Do want | 6 | 5 |
| Don't want | 1 | 0.8 |
| Unwritten | 4 | 2 |

As it is seen in Table 5, 91 % of students are not aware of SDU RAREC while 7 % of students are informed of this centre. Besides, a great number of students, namely 70 %, stated their willingness for the question whether they would participate a field trip to RAREC. Table 6 shows students'misconceptions about RERAs from Q1 shown italic.

**Table 6. The frequency of student misconceptions about RERAs from Q1**

| Misconceptions: Subject | Misconceptions: Sample sentences | Number |
|---|---|---|
| **Q1:** What are fossil fuels, renewable energy renewable resources and technologies? What's your opinion about them? | *Forming of fossil fuels take hundreds of years*<br>*Coal is formed by means of fossilization of flux mass.*<br>*Natural gas is a renewable resource*<br>*As forming of fossil fuels take a long time, they are not renewable.*<br>Examples:<br>**S105:** Fossil fuels used as energy resources in our daily lives (currently) are formed of fossilization of living beings bones' (animals etc.) in hundreds of years<br>**S2:** Coal is formed fossilization of flux masses, which takes very long time.<br>**S73:** Renewable energy resources are things such as natural gas and solar energy. | N=6 |

**Table 7. The frequency of student misconceptions about RERAs from Q2**

| Misconceptions: Subject | Misconceptions: Sample sentences | Number |
|---|---|---|
| **Q2:** Please explain how do solar collectors on the roofs of houses produce hot water? | *Black glasses on collectors collect heat and this made them work.*<br>*Electricity is made from reflection of sun light upon collector and this energy heats water.*<br>*Air must be warm to heat the water at collector.*<br>*Vibrant pipes heat the water of collector.*<br>Examples:<br>**S58:** It heats glasses. Heated glass effects water.<br>**S8:** Black glasses on collectors collect heat and they heat water.<br>**S17:** I learned during my primary education as once sun light comes to collector, electrons move and generate electricity.<br>**S:20** Cells on the houses' roofs contain water. When weather is warm and sunny, the cells getting sun light become hot and heat water.<br>**S:76** Solar energy heats water by means of panels. Vibrant pipes inside the panels and sun light provide heating. | N=17 |

Table 7 shows students'misconceptions about RERAs from Q2 shown italic. Table 8 shows students'misconceptions about RERAs from Q3 shown italic.

**Table 8. The frequency of student misconceptions about RERAs from Q3**

| Misconceptions: Subject | Misconceptions: Sample sentences | Number |
|---|---|---|
| **Q3:** How does photovoltaic cell generate electricity? What are they made from? | *Oxidation-reduction reaction occur at solar cell, chemical energy transformed electricity energy.*<br>*Solar cells works with taken from heat of sun.*<br>*Resistant to heat material made from solar cells.*<br>*Solar cells made from metals.*<br>*Solar cells charges and recharges.*<br>*There is conductive material in solar cells.*<br>Examples<br>**S7:** *Oxidation-reduction reaction must be happen at solar cells, its material is appropriate this situation, isn't it? I just know that it transforms chemical energy to electricity energy.*<br>**S16:** Solar cells taken heat from the sun, it provides to move from – to + and then produces electricity. I don't know what material they are made from.<br>**S50:** It may happen by means of emit highly heat energy from sun. So, it must be made from resistant to heat material.<br>**S92:** I have no idea about how solar cells produce electricity, but they are made from metals.<br>**S46:** By means of charged electrons. It made from iron and iron dust.<br>**S99:** A solar cells is the cells which are charged with solar energy.<br>**S104:** The sun energy get conductive material exposed to a reaction in the solar cells. And then transforms to energy. | N=21 |

Table 9 shows students'misconceptions about RERAs from Q4 shown italic.

**Table 9. The frequency of student misconceptions about RERAs from Q4**

| Misconceptions: Subject | Misconceptions: Sample sentences | Number |
|---|---|---|
| **Q4:** How do hydroelectric power plants at the dams generate electricity? | *Hydroelectric power plants generate electricity by pressure of water at dams.*<br>*Electricity is generated by turning of turbines at hydroelectric power plants*<br>*In hydroelectric power plants, electricity is generated by turning of transformers.*<br>*Density of waters at dams is high.*<br>*In hydroelectric power plants, electric energy is generated by means of turning of bobbins.*<br>*The electric energy generated in hydroelectric power plants is stored.*<br>Examples:<br>**S4:** Static water has potential energy. When water flows through spillways ( the doors opened), it gains kinetic energy<br>Water turns turbines by means of this energy. As turbines turns, energy comes out. This energy is stored.<br>**S26:** Water is pressured at dams and it is flown through a propeller. As this propeller moves, kinetic energy turns into electric energy.<br>**S120:** Water flows and this motion turns bobbins, which generate electricity.<br>**S103:** As it is known, water at dams is very powerful and water density is quite high. This water flows so powerfully that it accumulates motion energy and takes it back as electricity.<br>**S96:** The potential energy of waters at dams starts turning into kinetic energy when it is released and moves (turns) transformers. | N=23 |

Table 10 shows students'misconceptions about RERAs from Q5 shown italic.

**Table 10. The frequency of student misconceptions about RERAs from Q5**

| Misconceptions: Subject | Misconceptions: Sample sentences | Number |
|---|---|---|
| **Q5:** How is energy obtained from biogas? | *Biogas is used as fuel for cars and houses.*<br>*Biogas is self-formation energy.*<br>*It is formed by pressing animals' stools.*<br>*The gas getting out of nature.*<br>*Poisonous gases don't get out when bio gas burns.*<br>*Biogas doesn't damage to environment.*<br>*It is too much expensive to produce bio gas.*<br>*Bio gas is formed at underground.*<br>Examples:<br>**S1:** I've heard that bio gas doesn't damage to environment. As its name suggests it is formed by biological components.<br>**S26:** Biologically formed gas, self-formation gas.<br>**S35:** It is formed by pressing animals' stools.<br>**S50:** It can be the gas getting out of nature.<br>**S76:** They are a kind of gases which don't produce any poisonous smokes.<br>**S113:** Biogas is produced from organic substances. This process is too expensive. It doesn't give any harm. Pipelines are needed. Therefore, it is more expensive than others.<br>**S98:** Bio gas is produced at underground naturally and it is totally natural. | N=16 |

**Table 11. The frequency of student misconceptions about RERAs from Q6**

| Misconceptions: Subject | Misconceptions: Sample sentences | Number |
|---|---|---|
| **Q6:** What do you know about our country's potential of renewable energy resources? Explain, please. | *Boron mine is a renewable energy resource.*<br>*Turkey is a poor country in terms of renewable energy resources.*<br>Examples:<br>**S121:** There aren't many resources in our country or they are not developed.<br>**S122:** I know they are a little. (limited)<br>**S76:** Renewable energy resources constitute 75% of consumed energy. The most effective one is boron mine. | N=10 |

It seen that Table 6 students'misconceptions about RERAs from Q6 shown italic.

**Table 12. The frequency of student misconceptions about RERAs from Q7**

| Misconceptions: Subject | Misconceptions: Sample sentences | Number |
|---|---|---|
| **Q7:** What kind of relation exists between renewable energy resources technologies and saving the environment? Explain, please. | *Renewable energy resources don't have damages for environment.*<br>Examples:<br>**S86:** Since renewable energy resources can be reused, they are useful for environment. | N=1 |

It seen that Tables 6-12 students have many misconceptions about RERAs. Hydroelectric power plant, solar cells and its energy producing process, solar collector and working principles, and biogas topics which highly frequency statements stated by students.

**Table 13. The percentages of student career plan about RERAs**

| | | *f* | % |
|---|---|---|---|
| Career Plan (*N*=127) | | | |
| Willing students | | 24 | 19 |
| Unwilling students | | 103 | 81 |
| Reasons of RERAs career plans (*N*=127) | | | |
| Willing students | | | |
| | His/her interest area | 1 | .8 |
| | Insufficient studies this area | 6 | 4.7 |
| | It will be important for future | 5 | 3.9 |
| | It's better than none | 1 | .8 |
| | For environment | 4 | 3 |
| | I enjoyed the survey | 1 | .8 |
| | No comment | 7 | 5.5 |
| Unwilling students | | | |
| | His/her no interest area | 30 | 23.6 |
| | Different targets | 18 | 14 |
| | Lacks of knowledge about this career | 1 | .8 |
| | Lacks of prevalence | 5 | 3.9 |
| | Didn't think about it | 5 | 3.9 |
| | Unimportant career | 4 | 3 |
| | No comment | 40 | 31.4 |

As it is seen that Table 13, willing students to have career plan about RERAs rate is very low, 20% Students responses of open-ended questions has been put content analysis, the reasons of RERAs career plans are found out in several sub-themes such as his/her interest area, insufficient studies this area, it will be important for future, better than none, their sensitiveness to environment and influenced by questionnaire. Half of students stated that have no career targets about RERAs. The reasons they suggest for this situation are his/her no interest area, lacks of knowledge about this career, lacks of prevalence, didn't think about it and unimportant career.

## 5. Discussion and conclusion

In this study, investigating high school students' awareness and misconceptions of RERAs, it is seen that most of students respond to open-ended questions with no response or blank. In the views of these results, students' awareness and knowledge level of RERAs is very low [36, 42].

The fact that students' stating school and internet as knowledge resources of RERAs reveals that school and virtual world are very important for renewable energy education. There are many researches in literature having the same results that is school promotes energy education in addition to strengthening the cognitive dimension, but also establishing the correct energy attitudes of students [15, 43-45].

It is surprising that 91% of students are not aware of RACRER. Many researchers recommend field trip even meaningful field trip for renewable energy education [15, 46-48].

Students have many misconceptions about RERAs, determining of misconceptions is the first step and then it is stressed that clearing out misconceptions should be achieved by means of conceptual changing process which needs to use effective teaching method and strategies.

In the course of secondary education in which awareness of career is at the highest level for students, this study found that the rate of students planning to have career in RERAs is at a very low level (20%). Awareness of students about career of RERAs is important issue so lots of investment in energy sector and demands of qualified person increase this area [6, 17, 49, 50].

## 6. Implications

We firstly must be aware of the fact that the awareness of RERAs is at a very low level. Misconceptions about RERAs show that education of RERAs is not effective. Understanding of importance of RERAs education for students, who will shape our future, in the aspects of scientifically, economically and ecologically will affect prospective studies in the views of quantitatively and qualitatively [51-59.

## References

[1] Kaya D. Renewable energy policies in Turkey. Renew Sustain Energ Rev 2006;10:152–163
[2] Kaygusuz K, Sarı A. Renewable energy potential and utilization in Turkey. Energy Convers Manage 2003;44:459–478
[3] Evrendilek F, Ertekin C. Assesing The potential of renewable energy sources in Turkey Renewable Energy 2003; 28:2303–2315.
[4] Onal E, Yarbay ZR. Turkiye'de yenilenebilir enerji kaynakları potansiyeli ve geleceği. Istanbul Ticaret Univ Fen Bil Derg 2010; 9:77–96 [in Turkish].
[5] Gulay AN. Yenilenebilir enerji kaynaklari acisindan Turkiye'nin gelecegi ve Avrupa Birligi ile karsilastirilmasi. Master Thesis, Dokuz Eylul University, Izmir, 2008 [in Turkish].
[6] Acikgoz C. Renewable energy education in Turkey. Renew Energy 2011;36:606–611.
[7] Ozturel N, Zilan R, Ecevit A.turkiye'de Yenilenebilir Enerji Kaynaklari icin Izlenmesi Gereken Strateji, Planlama Politikalari ve Bunlarin Sosyal ve Siyasi Etkileri. Yenilenebilir Enerji Kaynaklari Sempozyumu, Izmir, 2001 [in Turkish].
[8] Demirbas A. Energy balance, energy sources, energy policy, future developments and energy investments in Turkey. Energy Convers Manage 2001;42:1239–1258.
[9] Yumurtaci M, Kecebas A. Renewable energy and its university level education in Turkey. Energy Educ Sci Technol Part B 2011;3:143–152.
[10] Demirbas MF. Educational approach to the future potential of energy and food crisis. Energy Educ Sci Technol Part B 2011;3:423–430.
[11] Saglam-Arslan A, Kurnaz MA. Students' conceptual understanding of energy: Do the learning difficulties in energy concept discovered in the 1990s persist still? Energy Educ Sci Technol Part B 2011;3:109–118.
[12] Kocakulah MS. Grade 8 students' conceptual patterns of conservation, transformation and types of energy. Energy Educ Sci Technol Part B 2011;3:153–172.
[13] Saidur R, Lai YK. Nanotechnology in vehicle's weight reduction and associated energy savings. Energy Educ Sci Technol Part A 2011;26:87–101.
[14] Tortop HS, Bezir NC, Uzunkavak M. Ogrencilerin Gunes Enerjisi Uygulamalari Konusundaki Basarilari ile Cevreye Iliskin Tutumlari Arasindaki Iliskinin Arastirilmasi. TMMOB Makine Muhendisleri Odasi Gunes Enerjisi Sempozyumu ve Sergisi, Mersin, 2007 [in Turkish].
[15] Tortop HS. Yapilandirmaci Yaklasima Gore Hazirlanan Alan Gezisi ile Desteklenmis Proje Tabanli Ogrenme Modelinin Gunes Enerjisi Ve Kullanım Alanlari Konusuna Uygulanmasi. Doctoral Thesis. Suleyman Demirel University, Isparta, 2010 [in Turkish].
[16] Poortinga W, Steg L, Vlek C. Values, environmental concern, and environmental behavior a study into household energy use. Environ Behav 2004;36:70–93.
[17] Jennings P. New directions in renewable energy education. Ren Energy 2009;34:435–439.
[18] Aktamıs H. Determining energy saving behavior and energy awareness of secondary school students according to socio-demographic characteristics. Educ Res Rev 2011;6:243–250.
[19] Bahar M, Aydin F. Sinif Ogretmenligi Ogrencilerinin Sera Gazlari ve Global Isinma ile Ilgili Anlama Duzeyleri ve Hatali Kavramlar. V. Ulusal Fen Bilimleri ve Matematik Egitimi Kongresi, Ankara, 2002 [in Turkish].
[20] Shin DS. Environmental education course development for preservice secondary school science teachers in the Republic of Korea. J Envi Educ 2000;31:11–18.

[21] Tanriverdi B. Surdurulebilir cevre egitimi acisindan ilkogretim programlarinin degerlendirilmesi. Egit Bil 2009;34:89–103 [in Turkish].
[22] Groves FH, Pugh AF. Elementary pre-service teacher perceptions of the greenhouse effect. J Sci Educ Tech 1999;8:75–81.
[23] Cin M. Sinif ogretmeni adaylaririnin sera etkisi hakkindaki kavram yanilgilari. Cukurova Univ Egit Fak Derg 2005;2:124–128 [in Turkish].
[24] Kishore P. High School Students' Understanding of factors that influence the efficiency of solar cells. Master Thesis. California State University, Long Beach, 2008. [25] Kilic FC. Recent renewable energy developments, studies, incentives in Turkey. Energy Educ Sci Technol Part A 2011;28:37–54.
[26] Ayas A. Karamustafaoglu S. Cerrah L. Karamustafaoglu O. Fen Bilimlerinde Ogrencilerdeki Kavram Anlama Seviyelerini ve Yanilgilarini Belirleme Yontemleri Uzerine bir Inceleme. X. National Educational Sciences Conference, Abant Izzet Baysal University, Bolu, 2001.
[27] Schmidt HJ. Students' misconceptions: looking for a pattern. Sci Educ 1997;81:123–135.
[28] Davlin M. Brown S. Findley K.Using Interviews to Identify Student Misconceptions in Dynamics. 37th ASEE/IEEE Frontiers in Education Conference, Milwaukee, WI, 2007.
[29] Costu B. Ayas A. Unal S. Kavram yanilgilari ve olasi nedenleri: kaynama kavrami. Kastamonu Egit Derg 2007;15:123–136.
[30] Kabapinar F. Orta Ogretim Ogrencilerinin Cozunurluk Kavramina Iliskin Yanilgilarini Besleyen Dusunce Birimleri. Yeni Bin Yilin Basinda Turkiye'de Fen Bilimleri Egitimi Sempozyumu, Maltepe University, Istanbul, 2001[in Turkish].
[31] Ozmen H. Determination of students' alternative conceptions about chemical equilibrium: A review of research and the case of Turkey, Chem Educ Res Prac 2008;9:225–233.
[32] Ulgen G. Kavram gelistirme kuram ve uygulamalar, PegemA Publishing, 3rd edition, Ankara, 2001 [in Turkish].
[33] Yilmaz O, Tuncer G, Aydemir M. An investigation on the elementary teachers' knowledge about air pollution issues. Hacettepe Univ J Educ 2008;35:374–385.
[34] Erol GH, Gezer K. Prospective of elementary school teachers' attitudes toward environment and environmental problems. Inter J Envir Sci Educ 2006;1:65–77.
[35] MEB. Ministry of National Education. Board of Education.http://ttkb.meb.gov.tr/, 2011.
[36] Nartgün SS, Altundag U, Ozen R. Ogrencilerin Sosyal ve Ekonomik Yasamlarina Dershanelerin Etkisi. 2nd International Conference on New Trends in Education and Their Implications. Antalya, Turkey, 2011[in Turkish].
[37] Yildirim A, Simsek H. Sosyal Bilimlerde Nitel Arastırma Yontemleri. Seckin Publishing, 3rd edition, Ankara, 2003 [in Turkish].
[38] Abraham MR, Grzybowski EB, Renner JW, Marek EA.Understandings and misunderstandings of eight grades of five chemistry concepts found in textbooks. J Res Sci Teac 1992;29:105–120.
[39] Calik M. A cross-age study of different perspectives in solution chemistry from junior to senior high school. Inter J Sci Math Educ 2005;3:671–696.
[40] Sendur G, Toprak M, Pekmez ES. Analyzing of Students' Misconceptions About Chemical Equilibrium. International Conference on New Trends in Education and Their Implications. Antalya, Turkey, 2010.
[41] Unal S, Ozmen H, Demircioglu G, Ayas A. A Study for determining high school students' understanding levels and misconceptions on chemical bonds. Fifth Conference on Science and Mathematics Education, Ankara, METU, 2002.
[42] Coker B, Catlıoglu H, Birgin O. Conceptions of students about renewable energy sources: a need to teach based on contextual approaches. WCES-2010. Procedia Social and Behav Sci 2010;2:1488–1492.
[43] Liarakou G, Gavrilakis C, Flouri E. Secondary school teachers' knowledge and attitudes towards renewable energy sources. J Sci Educ Tech 2009;18:120–129.
[44] Barak M, Dori YJ. Enhancing undergraduate students' chemistry understanding through project-based learning in an IT environment. Sci Educ 2005;89:117–39.

[45] Chiang W, Fang R, Nien HC, Tsa H. Renewable energy cognition and attitude of junior high school students in Kaohsiung city.10th WSEAS International Conference On Multimedia Systems & Signal Processing, 2010.
[46] Tortop HS, Bezir NC, Ozek N, Uzunkavak M. The field trip about solar energy and applications of the effect of students' attitude and achievement. International Conference on Environment: Survival and Sustainability, Near East University, Nicosia-Northern Cyprus, 2007.
[47] Kisiel J. Understanding elementary teacher motivations for science field trips. Sci Educ 2005;86:936–955.
[48] Elkins JT, Elkins NML. Teaching geology in the field: significant geoscience concept gain in entirely field-based inductory geology courses. J Geo Educ 2007;5:126–132.
[49] Alkan MA, Gedik E. Kecebas A. Turkiye'deki gunes enerjisi egitiminden beklentiler ve oneriler. TMMOB Makine Muhendisleri Odasi Gunes Enerjisi Sempozyumu ve Sergisi, Mersin, 2007 [in Turkish].
[50] Demirbas A. Energy issues in energy education. Energy Educ Sci Technol Part A 2011;27:209–220
[51] Kucuk M, Sugozu IH. Sectoral energy consumption and economic growth nexus in Turkey. Energy Educ Sci Technol Part B 2011;3:441–448.
[52] Onan A. Sustainable computing: Concepts and issues. Energ Educ Sci Tech-A 2011;28:379-392.
[53] Senel Coruhlu T, Calik M, Cepni S. Effect of conceptual change pedagogies on students' alternative conceptions of electricity resistance and electricity current. Energy Educ Sci Technol Part B 2012;4:141–152.
[54] Cakmak AC. Energy saving and a research about consumers' perceptions from the energy saving products: An application at Kahramanmaras city centre. Energy Educ Sci Technol Part B 2012;4:259-270.
[55] Serteller NFO. A basic introduction to finite element methods for solving electrical problems Energy Educ Sci Technol Part B 2011;3:487–496.
[56] Ballo F. Energy and economic analyses of insulated exterior walls for four different city in Turkey. Energy Educ Sci Technol Part A 2011;26:175–188.
[57] Hacihafizoglu O. Energy-exergy analysis of gas turbine cycle in a combined cycle power plant. Energy Educ Sci Technol Part A 2011;27:123–138.
[58] Mahlia TMI, Saidur R, Yanti PAA, Masjuki HH. Role of energy guide labels in consumers purchase decision for household electrical appliances. Energy Educ Sci Technol Part A 2011;27:95–104.
[59] Dikmen E, Sencan A, Selbas R. Energetic and exergetic approach to vapor compression refrigeration cycle with two-stage and intercooler for new refrigerants. Energy Educ Sci Technol Part A 2011;26:205–219.