

EXPLORING PRESERVICE SCIENCE TEACHERS' ENERGY
CONSERVATION BEHAVIOR THROUGH MOTIVATION, PSYCHOLOGICAL
NEEDS AND ATTITUDE: FURTHER SUPPORTED WITH THEIR
AWARENESS

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF SOCIAL SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

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IN PARTIAL FULFILLMENT OF THE REQUIREMENTS
FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY
IN
THE DEPARTMENT OF ELEMENTARY EDUCATION

SEPTEMBER 2017

Approval of the Graduate School of Social Sciences

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ABSTRACT

EXPLORING PRESERVICE SCIENCE TEACHERS' ENERGY CONSERVATION BEHAVIOR THROUGH MOTIVATION, PSYCHOLOGICAL NEEDS AND ATTITUDE: FURTHER SUPPORTED WITH THEIR AWARENESS

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September 2017, 317 pages

The primary focus of this study was to examine the relationships among attitudes toward energy conservation, self-determined motivation and basic psychological needs of preservice science teachers. To this end a model showing the relationship among these variables was suggested. In order to better understand the observed relationships in the model, interviews with PSTs were conducted. For the purpose of the study mixed method was used. In quantitative part of the study, 1136 preservice science teachers, who were enrolled in eleven public universities in Central Anatolia region of Turkey, participated in the study. In qualitative part of the study, 26 preservice science teachers enrolled in three public universities in

Ankara constituted the sample. Path analysis was used in order to examine the research questions in quantitative part of the study. After deleting the insignificant paths from the model, good fit indices were provided. The explained variance in energy conservation behavior was found as medium practical significance level. The highest correlation was found between self-determined motivation and eco-management type of energy conservation behavior. It is concluded that to support eco-management behavior type, PSTs' self-determined motivation should be supported. The qualitative data showed that the level of awareness of the majority of PSTs was relatively high in problems related to energy conservation. This high relationship might have contributed to the relationship between self-determined motivation and eco-management type of energy conservation behavior. In terms of problems related to energy policies and implications and energy resources, their awareness showed a variation from low to high. Therefore, it may be concluded that the majority of PSTs were not aware of the multiple dimensions of energy related problems and issues. This lack awareness may explain the low relationship between self-determined motivation and persuasion type of energy conservation.

Keywords: Energy conservation behaviors, self-determination theory, mixed method, teacher education

ÖZ

FEN BİLGİSİ ÖĞRETMEN ADAYLARININ ENERJİ TASARRUFU DAVRANIŞLARININ MOTİVASYON, PSİKOLOJİK İHTİYAÇLAR VE TUTUM ARACILIĞI İLE İNCELENMESİ: DAHASI FARKINDALIKLARI İLE DESTEKLENMESİ

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Eylül 2017, 317 sayfa

Bu araştırmanın temel amacı, fen bilgisi öğretmen adaylarının enerji tasarrufu davranışı, özerk benlik motivasyonu ve temel psikolojik ihtiyaçları, ve enerji tasarrufuna yönelik tutumları arasındaki ilişkileri incelemektir. Bu amaçla, bu değişkenler arasındaki ilişkiyi gösteren bir yol modeli önerilmiştir. Modelde gözlemlenen ilişkileri daha iyi anlamak için fen bilgisi öğretmen adayları ile görüşmeler yapılmıştır. Bu amaçla karma araştırma deseni kullanılmıştır. Araştırmanın nicel kısmında, Türkiye'nin İç Anadolu Bölgesi'nde bulunan 11 üniversitede öğrenim gören 1136 fen bilgisi öğretmen adayı katılmıştır. Çalışmanın nitel bölümünde, Ankara'da üç kamu üniversitesinden 26 fen bilgisi öğretmen adayı örnekleme oluşturmuştur. Araştırmanın nicel kısmında sorulan araştırma sorularına yönelik yol analizi kullanılmıştır. İstatistiksel olarak anlamlı bulunmayan yolları modelden çıkardıktan sonra, model uyum indekslerinin çalışmanın verileri ile uygunluğu desteklenmiştir. Enerji tasarrufu davranışında açıklanan varyansın etki büyüklüğü orta derecede bulunmuştur. En yüksek korelasyon, özerk benlik

motivasyonu ile fiziksel davranış arasında bulunmuştur. Fiziksel davranış türündeki enerji tasarrufu davranışını desteklemek için öğretmen adaylarının özerk benlik motivasyonlarının desteklenmesi gerektiği sonucuna varılmıştır. Nitel veriler, fen bilgisi öğretmen adaylarının çoğunun farkındalığın düzeyinin, enerji tasarrufu ile ilgili sorunlarda nispeten yüksek olduğunu gösterdi. Bu yüksek farkındalık, özerk benlik motivasyonu ile fiziksel davranış türündeki enerji tasarrufu davranışını arasındaki ilişkiye katkıda bulunmuş olabilir. Enerji politikaları ve uygulamaları ile enerji kaynaklarının etkileri ile ilgili problemler konusunda, katılımcıların farkındalıkları farklılık göstermektedir. Bu nedenle, katılımcıların çoğunun, enerji ile ilgili sorunların çok boyutlu yapısının farkında olmadığı sonucuna varılabilir. Bu düşük farkındalık, özerk benlik motivasyonu ve ikna edici türdeki enerji tasarrufu davranışı arasındaki düşük ilişkiyi açıklayabilir.

Anahtar Kelimeler: Enerji tasarrufu davranışları, öz benlik kuramı, karma araştırma deseni, öğretmen eğitimi

**To myself
&
My lovely husband**



ACKNOWLEDGEMENTS

I knew that this journey for getting PhD degree was very long and a painful process. I'm happy to have accomplished it. I'm very fortunate to have experienced this journey in Middle East Technical University. I met great people in the campus, who are hardworking and inspiring people with beautiful mind and heart. In addition to this, the campus itself was very inspiring with its beautiful ecosystem in which I felt peace and learned to be a part of nature. There are people, who supported me during this journey, and I present my pleasure to them below.

First of all, I would like to thank my advisor, Dr. Özgül Yılmaz Tüzün, who guided this dissertation and taught me how to survive in this process. I always admire her analytical and critical thinking skills in academic studies. There were times I came to her with crazy ideas, which were not doable studies regarding time and energy. In addition to this, there were times, she forced me for better writing. Thank you for challenging me, for all your advice and guidance.

I would like to thank my committee members, Dr. Özgür Erdur Baker, Dr. Elvan Şahin, Dr. Nejla Yürük and Dr. Sevgi Kınır. Their feedback and suggestions were precious for me. I would also like to thank Dr. Semra Sungur, who provided expert opinions on SDT and shared her knowledge in statistics. In addition to this, she always made me feel her support with her lovely smile. I also want to thank Dr. Gaye Teksöz and Dr. Elvan Şahin for expert opinions. I'm very happy to take courses on environment and sustainability education from them. I learned many things in those courses. It's been an honor for me to know all them in person.

I would like to thank Dr. Thomas M. Marcinkowski for hosting me as a visiting scholar in Florida Institute of Technology. During my visit, I learned many things from him regarding environmental education and how to be hardworking. He is an excellent role model to me. He answered all my questions in detail and helped me improve my analyses. All his advice and help were invaluable to me. Thank you indeed Dr. M. I'm very happy for meeting you.

There was a hidden co-advisor, who provided expert opinion and endless support. Thank you Dr. Cihan Yıldırım, my dear lovely husband. I would not completed this journey without your support and love. You provided me an excellent studying environment at home and studied with me until the late hours. There were hard times which challenged me psychologically, and you were always by my side to support me with your love. I'm very happy for sharing the life with you. I hope we live together for ever happily. Thank you my dear for being a part of this journey, for all your expert support and emotional support. I love you very much.

I would like to thank my family, Ramazan & Medine Çakır, who provides me unconditional love. Their ambition for education is always my light. In my whole life, their priority has always been my education, and they support this journey with all their heart. They have been always a supportive family in all my decisions. I'm very lucky for having them. This success is also their success.

I have great friends in my department at METU. Dr. Güliz Karaarslan-Semiz, Dr. Yasemin Özdem-Yılmaz, Dr. Kader Bilican, Dr. Işıl İşler, Dr. Büşra Tuncay-Yüksel, Mehmet Şen, Sinem Demirci, Gözde Kaplan, Emine Aytekin, Semanur Kandil, Okan Aslan and Dr. Gülsüm Akyol. We spent time together and I learned many things from them. They all are great friends and colleagues to me. Thank you all.

During this journey, there were friends I took courses together, prepared for proficiency exam and experienced writing thesis together. Dr. Nilay Öztürk and Meltem Irmak, I'm very fortunate to have experienced all the process with you. I always feel their support and friendship in this journey. Meltem you are the best writing body! I also would like to thank Hilal Yanış, who helped me during data collection and supported me in this process. You all are more than friends to me. Thank you very much girls.

I would like to thank Keeli Murdock, whom I met in Florida Institute of Technology. She was a great friend and made my days unforgettable in Melbourne, FL. I also would like to thank Dr. Semen Koksall, who helped me in Melbourne with

her friendship. In her busy days, she allocated time to me. All our conversations were invaluable. Hope to meet you two again.

I also would like to thank my dear friends, Selin Akdemir, Dr. Zerrin Aslan, Seher Demirel- Kütükçü and Dr. Ahmet Beyaz whose friendships are always with me even when we were in long distance. Their moral supports are precious in this journey.

I would like to thank Academic Writing Center in METU. The center guided by Dr. Esin Korkut Savul and Deniz Saydam. Thanks to this center, my writing skill has been improved, and my self-efficacy in writing has been increased. It was a great experience for me. Thank you all very much.

Finally, I acknowledge TÜBİTAK (The Scientific and Technological Research Council of Turkey) for the financial support. I am grateful for the scholarship I was granted during my PhD.

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LIST OF ABBREVIATIONS

ABBREVIATIONS

BPNEC	Basic Psychological Needs for Energy Conservation
ECB	Energy Conservation Behavior
EE	Environmental Education
ESD	Education for Sustainable Development
MTEC	Motivation Toward Energy Conservation
PST	Preservice Science Teacher
SDT	Self-Determination Theory
STS	Science Technology and Society
TPB	Theory of Planned Behavior
VBN	Value-Belief-Norm

CHAPTER 1

INTRODUCTION

The dependence on energy has been increasing dramatically and human beings have been facing many problems related to energy since the industrial period (Muller, 2012). For instance, CO₂ amount is increasing substantially in atmosphere since fossil fuels are burned to generate energy. This increase leads to climate changes, and it has various effects on natural and human systems. For example, rise in sea level due to melting glaciers causes the loss of coastal wetlands (Parry et al., 2007). Another example is the gulf oil spill in Gulf of Mexico in 2010, when an explosion caused the death of eleven people, serious health problems to people living around the area and damage on marine ecosystem (Goldstein, Osofsky & Lichtveld, 2011). These two striking examples among many others are representatives of all energy related disasters and show that these problems have multiple dimensions regarding their influence on society and environment (Muller, 2012).

In order to cope with the rising energy demand, more fossil fuels are needed to extract. It means digging the earth deeper (Goldstein et al., 2011). Wasteful household energy use has an important role in this growing demand (Poortinga, Steg & Vlek, 2004). Household energy consumption percentage was reported as 30% in the world and electricity is the second largest with 18% in energy consumption (International Energy Agency, 2010). This situation is not very different in Turkey. Household energy consumption in Turkey corresponds to 26% in energy consumption sectors (Yumurtaci & Donmez, 2013). Turkey is an energy dependent country. According to the 2013 statistics, imported energy resources percentage is 75%. This dependence of Turkey is increasing year by year due to the increase in energy demand (Turkyilmaz, 2015). When the amount of energy

produced for electricity in Turkey is considered, the major resource is fossil fuels. The statistics show that 64% is produced from thermal power plants, which use fossil fuels. On the other hand, 26% is produced from hydroelectric power plants and only 7% is produced from other renewable energy resources (Ministry of Energy and Natural Resources of Turkey, 2015). When these statistics and the main energy resource used for heating are considered, the major energy resource for household energy sector is still fossil fuels in Turkey (Yumurtaci & Donmez, 2013).

It is known that worldwide the main energy resource is still fossil fuels (Foster, Contestabile, Blazquez, Manzano, Workman & Shah, 2017; Hinrichs & Kleinbach, 2013; Titenberg & Lewis, 2015). Consumption of fossil fuels is directly affecting global climate change through greenhouse gases (GHG) emissions. Production of electricity by fossil fuels also has been leading to global climate change.

The studies have shown that the primary reason for the continuing increase in surface temperature of the earth is human activities (e.g., Anderegg, Prall, Harold & Schneider, 2010; Doran & Zimmerman, 2009; Oreskes, 2004). The major human activity leading to this increase is burning of fossil fuels (IPCC, 2014). As a result of burning fossil fuels, GHG emissions are released into the atmosphere causing global climate change (US GCRP, 2009). Climate change is a global problem requiring international cooperation for climate change mitigation (IPCC, 2014). The United Nations Framework Convention on Climate Change (UNFCCC) is the foremost international treaty on climate change, which took place at the Rio Earth Summit in 1992. The countries collaboratively work on how to mitigate the average global temperature increase and deal with the impacts of climate change. Followed by this, in 1997 the Kyoto Protocol was adopted, which is a binding agreement among nations to curb GHG emission (Shivakoti & Shrestha, 2014). Turkey became a party to this agreement in 2009 (Ministry of Environment and Urban Planning of Turkey, 2013). Recently, Paris agreement has been accepted at the 21st Conference of the Parties of the UNFCCC in Paris. The most obvious aim of the agreement is to reach a consensus on prevention of the temperature rise above 2 degrees compared to pre- industrial revolution period (UNFCCC, 2015). Another

attempt for decreasing the amount of GHG emissions is 2030 climate and energy policy framework endorsed by the European Commission (Scarlat, Dallemand, Monforti-Ferrario, Banja & Motola, 2015). This framework is a binding target for EU countries to decrease at least 40% domestic reduction in GHG emissions by 2030 when compared to the emissions of 1990. Another target is that at least 27% is set for the share of renewable energy consumed in the EU in 2030. One more striking objective is that at the EU level of at least 27% is set for improving energy efficiency in 2030 (European Council, 2014). Reduction of GHG emissions, emphasized in all international agreements, is one of the mitigation strategies for climate change (IPCC, 2014). In this context, energy conservation behavior (ECB) of citizens is important to decrease the GHG emissions and it contributes to mitigation of climate change (Von Borgstede, Andersson & Johnsson, 2013; Macovei, 2015; Senbel, Ngo & Blair, 2014).

Schools have a key role to increase awareness of energy conservation among citizens (Bodzin, Fu, Peffer & Kulo, 2013). Science education courses with emphasis on energy resources, energy generation, energy consumption and energy conservation can support students to acquire energy conservation behaviors (Bodzin, 2012; Bodzin et al., 2013; DeWaters & Powers, 2011b). Science teachers should be well educated with an awareness about importance of energy conservation in order to educate the future generations and make crucial decisions affecting the entire society (Koballa & Shrigley, 1983). To this end preservice science teachers' education programs are also critically important so as to prepare next generations as active responsible citizens conserving energy for a sustainable world (Mills & Tomas, 2013). In this present study preservice science teachers' (PSTs) energy conservation behaviors were investigated.

It has been known that ECB can be supported through science and environmental education (DeWaters & Powers, 2011b). Indeed, energy education programs in U.S (e.g., DeWaters & Powers, 2011a; KEEP, 2003) and United Kingdom (e.g., the project of *Energy Matters*, Heijne, 2003) have been developed specifically to increase ECB. Above all, in order to support the sustainability of the environment,

which we live in, people should have positive attitudes toward and motivation for energy conservation (Abrahamse & Steg, 2009; Cheung, Chow, Fok, Yu and Chou, 2016). People with positive attitudes toward energy conservation are more likely to save energy (Von Borgstede et al., 2013; Martinsson, Lundqvist & Sundstrom, 2011). Motivation also has a leading role in ECB. Based on the type of motivation, the frequency of behavior changes. People motivated internally are more likely to perform ECB than people motivated externally. Self-determined theory (SDT), which is a motivation theory, classified extrinsic motivation based on how autonomously these behaviors are regulated (Ryan & Deci, 2000a). Studies with SDT indicate that the types of extrinsic motivation show a variety in the degree of relation with ECB (e.g., Sweeney, Webb, Mazzarol, Geoffrey & Soutar, 2014). In this sense, this study particularly focused on the relationships among attitudes toward energy conservation, self-determined motivation and basic psychological needs of preservice science teachers. It has been assumed that energy conservation behavior of people can be explained in parallel to the relationships with self-determined motivation, basic psychological needs and attitudes toward energy conservation. For this purpose, a model showing the relationship among these variables was suggested in this study. In order to better understand the observed relationships in the model, interviews with PSTs were conducted. It is claimed that when people have awareness and information about a problem, their behaviors can be affected accordingly (Delmas, Fischlein & Asensio, 2013). We believed that this awareness and information can be gained through personal experiences and courses taken during their schooling. Based on this claim, it was thought in this study that the relationships, which were suggested in the path model, could be explained by the PSTs' awareness about energy related problems gained through these experiences.

In addition to the affective variables mentioned above, knowledge has a relationship with environmentally friendly behaviors (Hungerford & Volk, 1990; Ramsey & Rickson, 1977). However, in many current studies the relationship between environmental knowledge and environmentally friendly behavior was found small

or insignificant (e.g., Fielding & Head, 2012; Schultz, 2002). Specific to ECB, the study of DeWaters & Powers 2011, the relationship between ECB and affective variables was higher than the relationship between knowledge and ECB. Therefore, this study focus on affective variables and the model was constructed based on these variables. Among affective variables, the number of studies with SDT is limited. For that reason, SDT is one of the main interests in this study. Based on the above-mentioned issues in this study two main research interests were constructed. First, one focused on exploring the relationships among attitudes toward energy conservation, basic psychological needs, motivation toward energy conservation and energy conservation behavior (ECB) of pre-service science teachers (PSTs).

The specific research questions for the first research interest:

- What are PSTs' attitudes toward energy conservation, basic psychological needs, motivation toward energy conservation and energy conservation behavior?
- What are the relationships between energy conservation behavior (ECB) and the predictor variables of attitudes toward energy conservation, basic psychological needs, motivation toward energy conservation?

The second one focused on exploring the awareness of PSTs about energy-related problems since their awareness and information attained through personal experiences and courses taken at university can have a role in their ECB, attitudes and motivation for energy conservation. The specific research questions for the second research interest:

- How awareness about energy related issues explain the observed relationships among attitudes toward energy conservation, basic psychological needs, motivation toward ECB of PSTs?

The next sections of this chapter were specifically designed to justify the assumed relationships in the path model. To start this, first how ECB became a line of research in environmental education was presented below.

1.1 History of Environmental Education and Energy Education

The roots of environmental education (EE) can be traced to nature and outdoor education and conservation movements. As an example to nature education, Wilbur Jackman wrote *Nature Study for the Common School* in 1891 (McCrea, 2006). The major aim of this education is to develop an understanding toward the natural environment through making observations (Stevenson, 2007). Then, the conservation education paved the way to conservation movement in U.S. during 1930s. The Conservation movement in U.S. mainly aimed to raise awareness among Americans of the natural resources and protection of these resources during these years (Athman & Monroe, 2001). Then, outdoor education, which particularly aimed the exploration of nature through first hand experiences from an ecological worldview, gained popularity during 1950s (Athman & Monroe, 2001; Passmore, 1972). In 1960s and early 1970s, environmental problems, such as air and water pollution caused by factories, became more apparent to people, who especially lived in urban and industrialized areas (Dunlap & Jorgenson, 2012). In this period, the book of Rachel Carson's, *Silent Spring*, published in 1962 attracted the attention of people to the human impact on environment. This book made salient the impact of practices of modern agriculture on the species living in the environment. *Silent spring* refers to the extermination of species due to the use of chemicals, especially DDT, in agriculture (Athman & Monroe, 2001). Not only the effect of modern agriculture practices but also the effects of technological development and economic growth on environment raise the concern for the protection of environment and natural resources in 1970s. These concerns paved the way to the establishment of United Nations Environment Programme (UNEP) in 1972. Then,

in 1975, UNEP and UNESCO collaboratively founded UNESCO/UNEP International Environmental Education Programme (Palmer, 1997). Subsequently, UNESCO/UNEP organized the international workshop on environmental education at Belgrade in 1975. The Belgrade charter adopted at this conference framed the goal of environmental education briefly and presented the objectives of environmental education for the first time (Tolba, 1977). Followed by this, in order to represent environmental education at policy level, an intergovernmental conference on environmental education was held by UNESCO/UNEP in Tbilisi in 1977. It was the first inter-governmental conference in the history of environmental education. The major aim of this conference was to prepare suggestions for the application of environmental education worldwide. Tbilisi declaration was the output of this conference. This declaration contained the principles and objectives of EE, which was mainly based on the Belgrade charter (Palmer, 1997).

Although Tbilisi Declaration outlined a general framework for the EE, the curriculum developers confronted difficulties in determining instructional objectives (Hungerford, Peyton & Wilke, 1980). In order to deal with this problem, Hungerford et al. (1980) published a study, which shows the sub-goals of EE based on the objectives of Tbilisi for all grade levels. Thanks to this study, the objectives were clarified for further use by teachers. Furthermore, this study fostered the preparation of National Guidelines of Excellence Project of NAEE, which is a guideline for teachers to prepare lesson plans, develop a set of materials for EE (Marcinkowski, 2009). While studies on clarifying the objectives on EE and materials development projects were being carried out in 1980s and 1990s, The United Nations conducted the Conference on Environment and Development in Rio de Janeiro, Brazil in 1992. *Agenda 21*, an action plan agenda for sustainable development, is the product of this conference (McCrea, 2006). This is a comprehensive document with four sections and 40 chapters covering various topics such as poverty, equity, natural resources and education. Education is accepted as an application step of sustainable development within environmental education. According to *Agenda 21* “education is critical for promoting sustainable

development and improving the capacity of people to address environment and development issues.... It [education] is also critical for achieving environmental and ethical awareness, values and attitudes, skills and behavior consistent with sustainable development and for effective public participation in decision making” (UNCED, 1992, Chapter 36, p.320). Additionally, as a further step, educators are recommended to incorporate EE and sustainable development by taking environmental protection into consideration within formal and non-formal education.

In terms of environmental issues, protection of natural resources, climate change, and waste management are examples included in *Agenda 21* from the perspective of sustainable development. This document emphasizes certain impacts of climate change in terms of its effects on freshwater, economy in coastal area, and conservation and management of resources. So as to suggest solutions to energy issues, technological strategies (e.g., supporting research projects in renewable energy) and the importance of education in sustainability were addressed firmly (UNCED, 1992). Now that these issues have been included in Agenda 21, as educators, we need to improve energy conservation behavior (ECB) of future citizens. While attempting to improve these behaviors, students’ awareness about energy related problems, their motivation for and attitude toward energy conservation should be improved as well. These factors are all important in the development of their behaviors.

Sustainability or education for sustainable development (ESD) is still emphasized strongly in international conferences and commissions such as Earth Summit 2012 (Rio+20). Indeed, 2005-2014 declared as *Decade of Education for Sustainable Development* in order to incorporate the economic, social and environment dimensions of sustainability within teaching and learning (UNESCO, 2014). Based on this historical development, the EE programs are still evolving and the studies are continuing (Gough, 2013). To summarize, environmental education is evolved from natural studies, which covers protection of natural resources, to embracing

environmental problems with the social influences of these problems and sustainable development (Sauve, 1996).

As a more contemporary example regarding the response of the environmental problems of recent times, we can discuss energy education. (DeWaters, 2011). As a specific content, energy education regarding EE targets the energy-related behavior change in order to mitigate climate change. In this sense, human behaviors resulting in carbon emission are the primary target (Zografakis, Menegaki & Tsagarakis, 2008). It is interesting that the developments in energy education were not parallel with EE (DeWaters, 2011). Although energy-related problems result in environmental problems, energy education came to the agenda of U.S. in 1970s due to the Arab oil embargo. The principal aim of energy education in these years was to take precautions for this embargo instead of reducing the carbon emission to help climate change mitigation. The U.S. government called for energy education through media and schools in order to decrease energy use in the country. Although many educational materials were developed for K-12 in a short time period, efforts to extend this type of education was temporary since the embargo did not last long. Nevertheless, educational materials were developed during this period and these materials are still available (Katz, 1985 as cited in Barrow and Morrissey, 1989). The projects on energy education are still continuing in both U.S. and Europe. For instance, The Wisconsin K-12 Energy Education Program (KEEP) was started in 1993, and it is still an ongoing project. Another current example is Carbon Detectives Europe which was started in 2009 and ended in 2012. This project was supported financially by the European Union (Carbon Detectives Europe, 2012). In Turkey, EnverIpab project supported monetarily by the European Union and it was conducted between 2008 and 2009. The aim of the project was to increase awareness of public in buildings. For this purpose, activities for students and a guidance book for teachers were developed within the framework of this project (EnverIpab, 2008). Another EU-funded project is GREEN project in which Turkey is one of the partners. This project was started in 2013 and completed in 2016. The major aim of GREEN is to integrate climate change education into school

curricula with an innovative and creative manner in order to attract the interest of students. Within this projects both students at secondary level and their teachers benefited from it. The outputs of this project: (a) students' climate literacy was improved and they learned how to act climate-friendly, and they are all active learners in the project, and (b) teachers get familiar with current innovative approaches in education such as digital learning and evaluation strategies (GREEN, 2016).

One of the primary objectives in these energy education programs is to develop citizens' ECB. ECB are environmentally friendly behaviors, which primarily reduce people's carbon footprint. Decrease in carbon footprint help climate change mitigation. Shortly, ECB is a hot issue globally, and Turkey pays attention to this topic as well (e.g., EnverIpab, GREEN). The national science education curriculum of Turkey has engaged in a number of revisions recently (Ministry of National Education [MONE], 2017). Energy-related issues (e.g., energy generation, energy conservation, fuels, and renewable energy) were included in the curriculum in 6th, 7th and 8th grades. Therefore, investigating PSTs' ECB and factors having relation with ECB is important in order to raise awareness about energy-related issues among students of future.

1.2 Energy Conservation Behaviors and Self-Determination Theory

Energy conservation consists of a broad spectrum of activities from curtailing electricity use in household (e.g., turning off the lights when leaving a room) to consuming foods (e.g., buying local foods) (Steg, 2008). Such researchers as Abrahamse and Steg (2009), Reinders, Vringer and Blog (2003) and Vringer and Blok (1995) claim that two types energy conservation should be distinguished in the studies of household energy use. One is direct energy use such as using gas and lights. The other is indirect energy use in which the energy is embodied in the

products and services that are purchased by households. For example, consuming local foods help save energy. On the other hand, consuming exotic foods leads to use more energy since transportation and distribution of these products require additional energy. The amount of energy which is used in the process of transportation and distribution in exotic foods is indirect energy use (Abrahamse & Steg, 2009). Energy conservation is a complex issue that requires specifying the types of energy conservation. In this sense, the present study focused on the direct household energy use of PSTs. Besides, electricity consumption and heating in household were evaluated in direct energy use category.

The main energy resource for household energy is still fossil fuels. Carbon dioxide (CO₂) gas, revealed as a consequence of the consumption of fossil fuels, is one of the main causes of greenhouse effect. According to the statistics of 2014, CO₂ accounted for 81.7% of total greenhouse gas (GHG) emissions. Energy-related CO₂ emissions of Turkey have been increasing continually, and CO₂ emissions were 141.6% higher in 2014 than in 1990 (IEA, 2016). Household energy consumption was estimated as 26% in energy consumption sector (Yumurtaci & Donmez, 2013). The household CO₂ emissions increased 30% in 2014 when compared to the statistics in 1990 in Turkey (IEA, 2016). In order to mitigate climate change, CO₂ emissions should be decreased. Although energy efficiency has been increasing with the progression in technical devices, and the advancements in renewable energy have been improving, CO₂ emissions are still increasing. It shows that energy conservation still has an important role in order to help climate change mitigation (Johnson, 2016). Therefore, clarifying variables, which explain ECB, is crucial.

In order to identify the factors account for ECB, several theoretical models have been commonly used (e.g., Clement, Henning & Osbaldiston, 2014; Laudenslager, Holt & Lofgreen, 2004; Macovei, 2015; Sahin, 2013; Sweeney et al., 20014). One of these theoretical models is the theory of planned behavior (TPB). TPB is proposed by Ajzen to explain general human behaviors (Ajzen, 1991). As shown in Figure 1.1, TPB was based on intention to explain behaviors. In this model,

intention can be predicted by attitudes (i.e., personal beliefs about the perceived consequence of the behavior), subjective norms (i.e., normative expectation of others who are important to the person) and perceived behavioral control (i.e., the feeling of autonomy to perform the behavior) respectively (Clement et al., 2014). Furthermore, attitudes, subjective norms and perceived behavioral control are interrelated in this model. TPB has been studied to explain various types behaviors such as environmental behavior (e.g., Oreg & Katz-Gerro, 2006; Han, 2015), committing driving violation (e.g, Parker, Manstead, Stradling, Reason & Baxter, 1992) and smoking cessation (e.g., Norman, Conner & Bell, 1999).

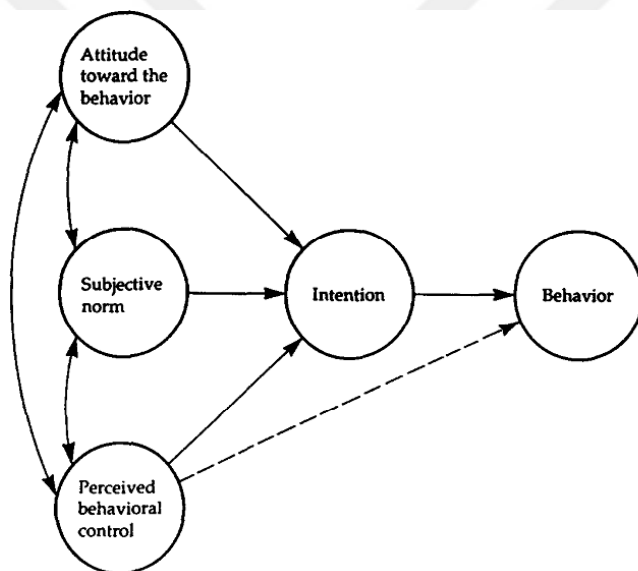


Figure 1.1 Theoretical model of TPB (Ajzen, 1991, p.182)

In environmental education (EE), Hines et al. (1987) offered “Model of Responsible Environmental Behavior” based on the TPB of Ajzen and Fishbein (1977). The study is a thorough meta-analysis with 128 studies. As social-psychological constructs, attitudes, locus of control, personal responsibility were used to predict pro-environmental behavior. It is found that all those variables are significantly related to pro-environmental behavior. TPB has been also used in ECB studies. For instance, Clement et al. (2014) studied household ECB of college students with

TPB. The study shows that the perceived behavioral control is the strongest predictor for ECB. It means that when the participants perceive ECB as easy and under personal control, they conserve energy. The authors claim that energy conservation requires a continual commitment that can affect perceived behavioral control easily. This commitment can also be affected by motivational drivers (Werner & Makela, 1998). It has been known that when people have self-determined motivation about a behavior, they tend to perform the behavior for a long time (Ryan & Deci, 2006). Therefore, it is thought that investigating ECB from the view of self-determination theory can present substantial evidence to understand ECB of PSTs. For this reason, self-determination theory was utilized in the present study. In addition to TPB models, another commonly used theoretical model is value belief norm (VBN) theory, which is explained further below.

Value Belief Norm theory, an extended version of the norm-activation model (Schwartz, 1977), was proposed by Stern Dietz, Abel, Guagnano, and Kalof (1999). This theory proposes a causal linear relation as shown in Figure 1.2. According to this model, personal values (i.e., egoistic values and altruistic values) cause beliefs, and beliefs cause personal norms. Then, the personal norms cause behavior. The norm activation model and the VBN theory have been widely used to understand pro-environmental behavior (e.g., Hopper & Nielsen, 1991; Gärling, Fujii, Gärling & Jakobsson, 2003; Nordlund & Garvill, 2003; Steg, Dreijerink & Abrahamse, 2005; Stern, et al., 1999).

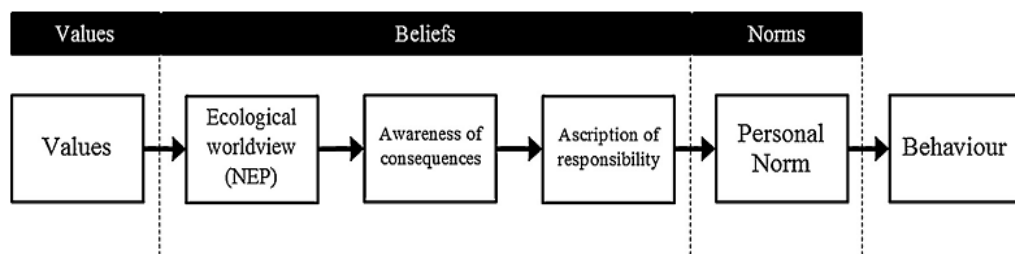


Figure 1.2 Theoretical model of VBN (Klöckner, 2013, p.1031)

The VBN theory has also been extensively used with ECB (e.g., Abrahamse & Steg, 2011; Ibtissem, 2010; Kaiser, Hubner & Bogner, 2005; Sahin, 2013). As a

representative example for ECB, with regard to pro-environmental behavior, the study by Abrahamse and Steg (2011) shows that, the VBN theory explains 15% variance of households' energy use. Furthermore, this study used both VBN and TPB to find out which theory explains the energy use more. It shows that TPB explained 5% variance in energy use, which means that the VBN theory explained more variance in terms of energy use of households. Another example for the use of the VBN theory in energy-related investigation is the study of Sahin (2013). This study shows that 28% of variance in energy behavior of pre-service teachers is explained by VBN theory. The respondents in these two studies are different and the number of participants also shows differences. Besides, Abrahamse and his colleague used meter readings for energy use, but Sahin (2013) utilized a self-report energy conservation instrument to measure the ECB of preservice teachers. These two reasons may have affected the results of these studies. Similar to the study of Sahin (2013), this current study used a self-report instrument to measure the ECB of PSTs since many of them stayed at the dorm and they were unable to measure the amount of energy they use through meter reading.

As the studies (e.g., Abrahamse & Steg, 2011; Stern et al, 1999; Kaiser et al., 2005, Sahin, 2013) show, both TPB and VBN are comprehensive and well-constructed theories to predict pro-environmental and energy conservation behavior. Although correlations between behavior and the other constructs in these models (i.e., intention to act, personal norm) are expected in the studies, researchers using these two theories provide limited explanations as to why individuals have intention to act. Two persons may have intention to act but one may perform the behavior and the other may not perform the behavior (Darner, 2009; Pelletier & Sharp, 2008). In order to fill this gap in behavioral studies, Deci and Ryan proposed Self-determined theory (SDT). SDT, a type of motivation theory, distinguishes these reasons to provide more information about why individuals perform pro-environmental behavior. For example, a person conserves energy since s/he thinks this behavior is consistent with her environmental values, whereas another person performs this behavior since s/he thinks it is a meaningful behavior. One other person may

conserve energy in order to be accepted in the community s/he lives in. Further explanation of this motivation theory is provided below.

Motivation, as a psychological construct, is one of the reasons that leads individuals to initiate, maintain and sustain such behaviors (Darner, 2012; Pelletier et al., 1998). For that reason, motivation has been receiving a good deal of attention in both environmental education and science education (Black & Deci, 2000; Pelletier et al., 1998). This present study draws attention to the role of SDT in the investigation of energy conservation behavior (ECB) of PSTs. The rationale for selecting SDT to explore ECB of PSTs is fourfold. First, it provides considerable insights to distinguish different types of motivation which can have a role in integrating and maintaining human behaviors (Pelletier, Baxter & Huta, 2011) Second, this theory takes the quality of motivation (i.e., self-determined types of motivation as intrinsic, integrated and identified regulation) into account in order to understand the motivational outcomes (Vallerand, Pelletier & Koestner, 2008). For instance, college students with self-determined motivation are more likely to have pro-environmental behaviors (Green-Demers, Pelletier & Menard, 1997). Third, the internalization issue, which is a process of transforming external regulations into internal regulations and then modifying those regulations into one's part of character, is taken into consideration in the theory (Deci, Eghrari, Patrick & Leone, 1994; Vallerand et al., 2008). Finally, SDT offers reasoning for internalization process of the environmental behavior (Darner, 2009; Vallerand et al., 2008). For example, a person conserves energy since s/he thinks that it is a part of his/her identity. SDT and its place in energy conservation context is explained below.

SDT was developed first by Deci and Ryan (1985) in an effort to reveal how various types of self-determined behavior are explained with the varying degrees of motivation. The theory includes extrinsic and intrinsic types of motivation and amotivation. In this context, a continuum based motivation framework is proposed (see Figure 1.3. In this continuum basis, Deci and Ryan (1985) put forward six types of motivation (i.e., intrinsic, integrated, identified,

introjected, external, and amotivation). In this classification, specifically for SDT, the extrinsic motivation type shows a variation. That is, external, introjected, identified and integrated types of motivation are distinguished based on the internalization degree. To illustrate, if the extrinsic type motivation is closer to intrinsic motivation, it is more internalized into one's character and it is more self-determined. On the other hand, if the extrinsic motivation type is closer to amotivation, it is less internalized and it is less self-determined. For instance, integrated type of motivation is closer to intrinsic motivation, and external type of motivation is closer to amotivation in the continuum basis. It means that integrated motivation is more internalized, and more self-determined than external motivation. Each of these motivation types is explained below by providing examples in energy conservation context as used in this present study.

The second type of motivation, extrinsic motivation, concentrates on the positive consequences of behavior or the focus is the avoidance of negative consequences (Deci & Ryan, 1985; Pelletier et al., 1998). Deci and Ryan (1985) propose that external reasons set for the behavior can be regulated and internalized into one's value system. Therefore, extrinsic motivation is multidimensional (i.e., integrated regulation, identified regulation, introjected regulation and external regulation) in that the degree of internalization shows a variety among the dimensions. This multidimensional form of extrinsic motivation is unique to SDT (Ryan & Deci, 2000a; Pelletier et al., 1998). These varying levels allow for a more detailed understanding of individuals' externally motivated behaviors. If the internalization degree increases in external motivation, the person gets closer to intrinsic motivation in that the person's behavior is more self-determined (Ryan & Deci, 2000a).

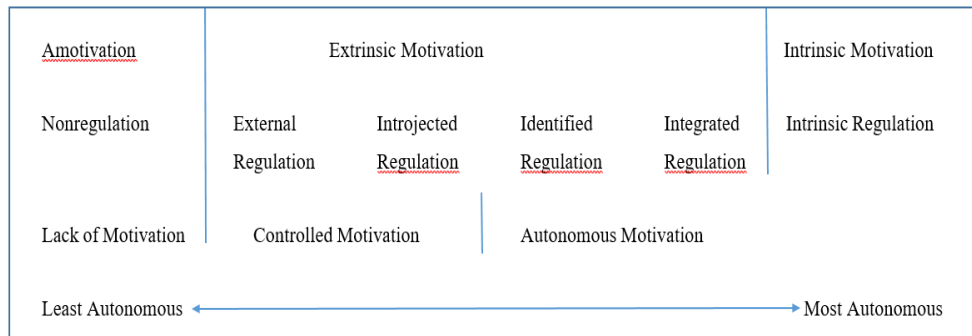


Figure 1.3 The types of motivation and regulation types within SDT and its representation with a continuum basis (Ryan & Deci, 2008, p.663).

The first type of extrinsic motivation, external regulation, includes behavior, which is regulated by external sources such as reward or punishment (Pelletier et al., 1998). It is the closest type to amotivation. Therefore, Deci and Ryan (1985) accept it as a non-self-determined type of behavior motivation. A person with external regulation is motivated by being appreciated by parents or peers to conserve energy.

The second type, introjected regulation, refers to behavior, which is not led completely by external sources. Rather, the behavior is performed due to the internal pressure (Pelletier, et al., 1998). In other words, external stimulants (e.g., parents' pressure) are transformed into inner stimulants, but they are not definitely accepted as one's own (Legault, Green-Demers & Chung, 2007). A person with introjected motivation performs the behavior to avoid shame and to avoid diminishing self-esteem (Ryan & Deci, 2000a; Ryan & Deci, 2000b). As compared to external regulation, introjected regulation is more internalized and autonomous. Specific to energy conservation behavior, the person with introjected regulation conserves energy to avoid the feeling of guilt.

The third type, identified regulation, refers to behavior that is perceived as important and valuable (Deci & Ryan, 1990; Ryan & Deci, 2000b). A person with this regulation admits the importance and significance of the behavior, which shows that the locus of causality transforms inward. However, it is still not a part of the individual's core personal beliefs. That is, the behavior is more internalized than

introjected regulation but it is not entirely integrated into the person's value system. However, the behavior is accepted as important (Legault et al., 2007; Ryan & Deci, 2000a). In terms of ECB, the person with identified regulation conserves energy since s/he accepts it as a meaningful behavior.

The fourth type, integrated regulation, refers to behaviors that are assimilated into one's value system. Indeed, the behavior is utterly internalized into the self. Therefore, it is the most self-determined extrinsic motivation type (Legault et al., 2007; Ryan & Deci, 2000a). That is to say, the behavior is constructed as a sense of identity. Integrated regulation and intrinsic motivation show similarities. For example, behavior is performed autonomously in both types. However, integrated regulation is still considered as extrinsic since the behavior is acted in order to be consistent with one's value system rather than as a pleasure or feeling of joy (Darner, 2009; Legault et al., 2007). In energy conservation context, the person internalizes ECB, since this type of behavior is consistent with her value system. For instance, one can conserve energy since conserving energy is a part of his/her life.

The final motivation type in SDT is intrinsic motivation. Intrinsic motivation stands for the apex of self-determination. In this type of motivation, the behavior is exhibited due to the sense of satisfaction or enjoyment (Lagault et al., 2007). A person with intrinsic motivation for a behavior maintains the behavior in the absence of external reinforcements, and the behavior is still performed despite external barriers (Legault et al., 2007; Ryan & Deci, 2000b). In energy conservation context, a person may conserve energy since s/he likes the feeling of pleasure when conserving energy. However, the number of people with intrinsic motivation for a particular behavior (e.g., energy conservation behavior, recycling behavior, etc.) is very limited. External forces are often required in order to engage people in a particular behavior (Legault et al., 2007). For that reason, revealing the variety in external motivation would contribute to our understanding as to how to improve educational settings in order to promote ECB of students.

In addition to the motivation types, another focus of SDT is psychological needs. Within the framework of SDT, Deci and Ryan (1985, 1991) address three psychological needs, which vigorously promote self-determined motivation. These needs are namely, autonomy, competence and relatedness. Autonomy refers to feeling volitional about the behavior. (Ryan & Deci, 2008). With respect to ECB, the term autonomy refers to acting for energy conservation willingly. Competence refers to feeling effective in performing the behavior (Ryan & Deci, 2008). People having competence also know where to find the required information and help. Along these lines, feeling of competence matches with perceived self-efficacy of Bandura, which focuses on the beliefs of a person about himself/herself regarding to achieving certain things (Cooke, Fielding & Louis, 2016). It is important to note here that if competence is not associated with autonomy, intrinsic motivation is not raised (Ryan & Deci, 2000a). People having competence with regard to energy conservation would feel that they are capable of conserving energy or that they know how to conserve energy and how to find information about it. The final basic psychological need is relatedness, which refers to feeling of being connected to a social environment or a community (Ryan & Deci, 2008). High relatedness would be reflected in a positive way for a society in that people may discuss the ways to conserve energy and support each other to conserve more energy.

PSTs are the teachers of the future, and they are role model for students. Therefore, investigating their behavioral pattern in energy conservation is important. A theoretical model, proposed in this present study, investigated the direct relationships among motivation types, basic psychological needs, attitudes toward energy conservation and ECB. Therefore, the studies investigating these relationships are exemplified from the literature below.

As mentioned above, SDT has been used in various disciplines (e.g., health studies, physical activities, environmental behaviors) to explain human behaviors (Deci & Ryan, 2000; Ryan & Deci, 2008). The number of studies investigating the relationship between SDT and pro environmental behavior is limited (Darnier, 2009, 2012). However, there has been evidence that the relationship between self-

determination and pro-environmental behavior is significant. For instance, the study of Green-Demers et al. (1997) investigates the relationship between self-determined motivation and pro-environmental behavior of college students. The study found that college students' pro-environmental behavior is positively related to their self-determined motivation. Likewise, the finding of the study by De Groot and Steg (2010) investigated the relationship between self-determined motivation and pro-environmental behavior with 304 university students. In this study two types of environmental behaviors were defined as pro-environmental, which are choosing a car based on environmental performance and donating to an environmental organization. It was found that intrinsic motivation, integrated regulation, identified regulation and introjected regulation were significantly and positively related to car choosing based on environmental performance. However, there was not a significant relationship between external regulation and car choosing. Furthermore, a negative relationship was found with amotivation. In terms of the results for making donation to environmental organizations, it was found that a positive and significant relationship were found with intrinsic motivation, integrated regulation, identified regulation and introjected regulation. On the other hand, the correlation with external motivation was found insignificant and the correlation with amotivation was found negative.

In addition to those studies, Darner (2009)'s experimental study provides further information about the implementation of the SDT in teaching setting. Darner (2009) designed an SDT-guided biology course for university students whose major were Biology. The content of the course focused on local environmental issues and field trips. The author supported the basic psychological needs (i.e., autonomy, competence and relatedness) of students in the experimental group. Then, students' motivation toward pro-environmental behaviors was compared. The scores of motivation types (i.e., intrinsic, integrated, identified, introjected, external, amotivation) were higher in SDT-guided group except for amotivation which is lower in experimental group. However, the difference is insignificant except for amotivation. Amotivation score of SDT group was lower than the control group.

The results suggest that SDT based course seem to foster self-determined motivation of students through the satisfaction of basic psychological needs. However, the results of the same study also show that which features of the course supports basic psychological needs of SDT is unclear (Darner, 2009). This vagueness poses an ambiguity in the investigation of which types of basic psychological needs have a relationship with pro-environmental behaviors and self-determined motivation. The study of Cooke et al. (2016) sheds a light on this problem in their study. The study measured three types of pro environmental behaviors, namely easy pro environmental behavior (e.g., participating in marches or protests about environmental issues, only use the washing machine when it is full), difficult pro environmental behavior (e.g., minimizing the amount of meat you eat, participating in marches or protests about environmental issues) and carbon footprint. The study conducted with people who are active about environmental problems. The study reveals that all basic psychological needs have a positive significant relationship with easy and difficult pro environmental behavior. However, these basic psychological needs have a negative relationship with carbon footprint. The study of Osbaldiston and Sheldon (2003) also provides evidence for the relationship between basic psychological needs and pro-environmental behaviors. This study was performed with 162 college students. It was revealed in this study that in order to engage students in pro-environmental behavior, their need for autonomy should be supported. When this condition is provided, the students internalized the pro-environmental behavior and they develop self-determined motivation for these behaviors. All these results show that basic psychological needs and motivation types described in SDT have an important role in predicting pro-environmental behaviors. As a type of pro-environmental behavior, it may be inferred that ECB can be predicted from basic psychological needs and motivation types described in SDT. The literature also includes some studies investigating ECB based on SDT. Most of these studies have been conducted with householders unlike the present study. The present study has been conducted with PSTs. The representative studies for ECB were exemplified below.

For instance, a study for ECB was conducted by Webb, Geoffrey, Soutar, Mazzarol and Saldaris (2013) with 200 householders living in Australia whose ages were between 18 and 70. ECB was measured with eight items (e.g., turn off the lights when not in the room, turn all unnecessary appliances off completely when not in use, and use energy efficient light bulbs). The findings showed that the relation between self-determined motivation and ECB was found positive and significant and the relation between amotivation and ECB was found insignificant. A similar study was conducted by Cheung et al. (2016) with 1004 people who were between the ages of 18 and 70 and living in Hong Kong. Energy conservation was measured with four items (i.e., wearing a thicker jumper in winter instead of turning the heating up, making an effort to use public transportation, selecting energy efficient appliances when purchasing such items, waiting until you have a full washing load before doing the laundry). The results revealed that the relationship between self-determined motivation and ECB was positive and significant that householders who internalized energy conservation conserve energy more. The relation between external motivation and ECB was found negative and significant. People who conserve energy for external reasons (e.g., getting appreciation) conserve less energy. Furthermore, the study found an insignificant correlation between amotivation and ECB. Another study whose focus was ECB was conducted by Sweeney et al. (2014). This study was an experimental study, which was conducted via internet. The experimental design in this study was constructed based on the SDT. The study was conducted with 696 householders in Australia. The study showed that although ECB of householders is mostly driven by habit, SDT based instruction led an increase in ECB. Furthermore, the results show that the basic psychological needs are supported in the online intervention. The results in this study also show that when the self-determined motivation increases, ECB of householders also increase. In short, it can be concluded from all these studies that self-determined motivation and basic psychological needs have an important role in predicting ECB of people.

In addition to this, the study by Wilson, Rodgers, Blanchard and Gessel (2003) claims that attitude is related to self-determined motivation. Furthermore, studies also show a moderately significant relation between attitudes and ECB (e.g., Abrahamse & Steg, 2011; Ajzen & Fishbein, 2000; Clement, et al., 2014; Macovei, 2015). Therefore, attitude toward energy conservation is included in the present study with SDT in order to predict ECB of PSTs.

1.3 Attitudes toward Energy Conservation and Energy Conservation

Behaviors

The relationship between attitude toward energy conservation and energy conservation behavior (ECB) can be considered as another psychological variable (Abrahamse & Steg, 2009). Attitude is a vague term in the literature, because the terms namely, attitudes, beliefs, values, concerns and worldview are used interchangeably in many studies (Schultz, Shriver, Tabanico & Khazian, 2004). All these terms are generally measured via New Environmental Paradigm (NEP) scale (Dunlap, Liere, Mertig & Jones, 2000). The authors of the scale inform the researchers that the items in NEP seem to form a major component of primitive belief systems of people. In order to deal with the confusion with the use of attitude term in environmental education, Schultz et al. (2004) define environmental attitude as following: “the degree to which a person has a favorable or an unfavorable evaluation of a behavior, and depends on the weighing of various costs and benefits such as financial costs, effort, or time” (p. 712). Energy conservation is a specific behavior type. Therefore, instead of measuring a common attitude toward environment, specific attitudes of participants, namely attitudes toward energy conservation was measured in the present study. Abrahamse and Steg (2009) defined attitudes as follows: the degree to which a person has a favorable or an unfavorable evaluation of a behavior, and depends on the weighing of various costs and benefits such as financial costs, effort, or time (p. 712). This definition refers to the degree of favorability a person holds for energy conservation. That is, a high

score refers to positive attitudes toward energy conservation, and a low score refers to negative attitudes toward energy conservation. For instance, a person with positive attitude favors energy conservation and willing to devote his/her effort and time for this behavior. A person with negative attitude; however, would be unwilling to devote this effort and time for energy conservation.

The studies investigating the relationship between attitudes and ECB show that these two variables have a positive relationship. For example, the study of Gadenne et al. (2011) showed that attitudes were positively correlated with ECB. Many studies investigating this relationship support the positive significant correlation (e.g., Martinsson et al., 2011; Von Borgstede et al., 2013). In addition to attitudes, socioeconomic factors are studied as a strong predictor for ECB. Martinsson et al. (2011) concluded that the influence of attitudes is stronger with the residents living in apartment blocks.

To summarize, based on the studies mentioned above, a positive relationship between attitudes toward energy conservation and ECB was expected to be found in this present study. In addition to attitudes, motivation has also an important role in the explanation of ECB of people (Kaplowitz, Thorp, Coleman, & Yeboah, 2012; Koballa, 1984; Mills & Schleich, 2012). Furthermore, some studies reveal the relationship between attitudes and motivational factors (Kotchen & Reiling, 2000). For instance, the study of Gadenne, et al. (2011) showed that intrinsic and extrinsic motivations were associated with attitudes on ECB. There are also few studies, even though their focus were not ECB or pro-environmental behavior, support the relationship between self-determined motivation, a specific motivation type, and attitudes. For example, the study of Wilson et al. (2003) found that psychological needs, self-determined motivation and attitudes were all related to the physical fitness context. It has been inferred from the results of previous studies that studies investigating the relationships among attitudes toward energy conservation, psychological needs and self-determined motivation in energy conservation context are lacking. For that reason, it is believed that this study have potential to provide information to the literature.

To summarize, although the number of studies on the relationship among motivation toward energy conservation, basic psychological needs and ECB is limited, based on the studies in pro environmental behaviors and the studies on ECB with householder, our expectation is that positive relationship between basic psychological needs, self-determined motivation and ECB are expected. Furthermore, a negative relationship between external motivation and ECB, and amotivation and ECB are expected. A model showing the expected relationships is proposed below. The next section is devoted to the explanation of model and the significance of the study.

1.4 Overview of the Proposed Model

Based on the studies in the literature mentioned above, a model is proposed in order to explain the energy conservation behavior (ECB) of preservice science teachers. The proposed model includes four variables, namely attitudes toward energy conservation, basic psychological needs, motivation toward energy conservation and ECB. Attitudes toward energy conservation is unidimensional. Basic psychological needs have three subcomponents. That is, autonomous, competence and relatedness. Motivation toward energy conservation has six components, namely intrinsic motivation, integrated regulation, identified regulation, introjected regulation, external regulation and amotivation (see Figure 1.4).

It was proposed in the model that attitudes toward energy conservation and the dimensions of basic psychological needs (i.e., autonomous, competence and relatedness) and motivation toward energy conservation (i.e., intrinsic motivation, integrated regulation, identified regulation, introjected regulation) are directly linked to PSTs' ECB (see Figure 1.4 and Figure 1.5).

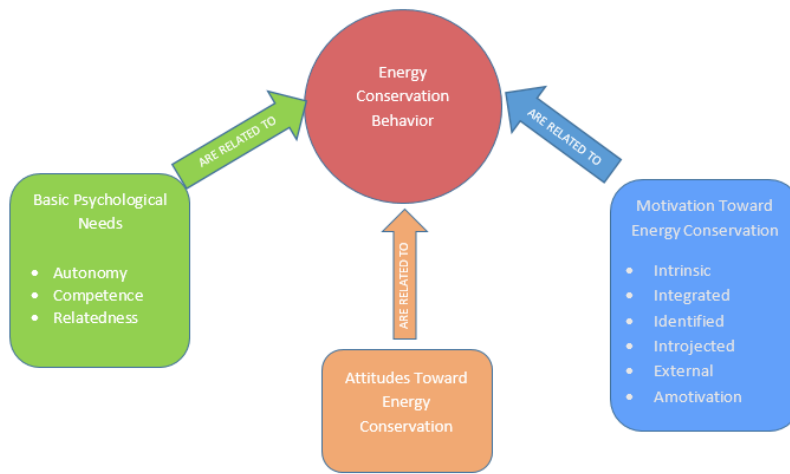


Figure1.4 Graphical representation of the variables in the present study

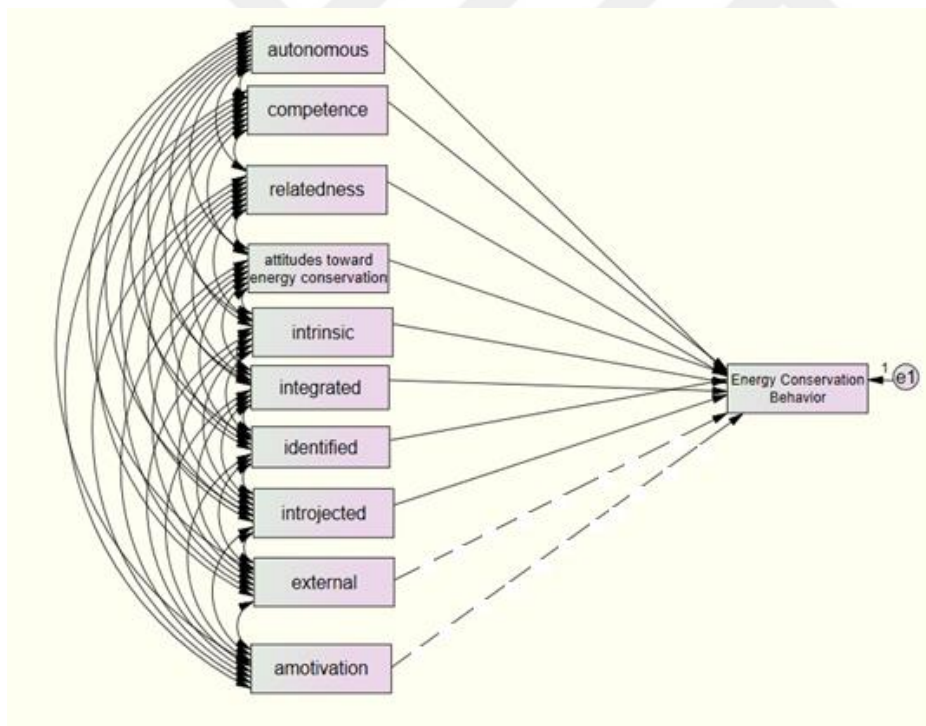


Figure 1.5 The proposed guided model to explain ECB of PSTs

*the dashed lines stand for the negative relationships

Furthermore, in order to grasp the reasons for the observed relationships in the path model, qualitative research was embedded into the present study. In that, it was thought that PSTs' awareness about the energy-related problems can have a role to explain their attitudes, motivation and their ECB. In this sense, awareness about energy-related problems may have a role in internalization of ECB and improve teachers' self-determined motivation. The qualitative dimension of this study presented data to describe PSTs' level of awareness about energy conservation behavior regarding observed relationships in the model. In the next section how awareness about energy conservation behavior have been investigated in earlier studies and lead the issues investigated in this current study were explained.

1.5 Awareness of Energy Related problems and issues

One of the objectives targeted in Tbilisi declaration is awareness of environmental problems. Awareness is defined in this declaration as “helping social groups and individuals acquire awareness and sensitivity to the total environment and its allied problems” (UNESCO/UNEP, 1978, p.15). Kollmus and Agyeman (2002) defined awareness within two domains. One is having information about the environmental problems and issues. The other domain is the affective domain, which corresponds to emotional involvement about these problems and issues. In this context, awareness about energy-related problems refers to having information about energy-related problems and issues, which have consequences on environment, society and economy and holding emotional involvement on these consequences. In terms of education for sustainability perspective, PSTs awareness of energy-related problems is crucial in order to provide a sustainable view to students. Furthermore, if students have a sense of these multiple dimensions, their attitudes, motivation and behavior may change. For example, the study of Yilmaz, Boone and Anderson (2004) with 4th to 8th grade students revealed that there was a difference in the extent students' agreed with respect to the importance of environmental

issues. When the students were led to consider environmental issues with economic growth, they tended to opt for economic growth over the environmental protection. This result may imply that individuals' awareness about several aspects (e.g., economy, society, policy) of an issue may have a role in their attitudes and motivation toward this issue. In addition, this awareness can have a role in their ECB.

Awareness of energy-related problems is also important for a sustainable worldview. PSTs' awareness of environmental problems with environmental, economic and social dimension is important in that energy-related problems are complex issues, which include all these dimensions. For example, consuming fossil fuels contribute to global warming, which is an environmental outcome of this problem. Generating energy from renewable energy (e.g., wind power, hydropower, bioenergy, etc.) is offered as a solution to fossil fuel consumption. However, generating energy from renewable energy has its own disadvantages (Edenhofer et al., 2011). For example, the dams can force people leave their town, which is a social outcome of energy problem (Arias et al., 2014). It is claimed that wind power stations cause some health problem (e.g., headaches) for people who live close to these plants. Another example is that energy policies of countries raise some concerns for people (e.g., construction of a nuclear power plant). From an economic standpoint, importing energy resources cause some economic problems (Edenhofer et al., 2011; Harris & Roach, 2013; Tietenberg & Lewis, 2012). There are many other examples to this issue. As exemplified here, energy-related problems are complex in nature, and these problems have environmental, economic and society dimensions. There are four fundamental reasons for investigating PSTs' awareness.

First reason, the number of studies in environmental education literature related to PSTs' awareness about energy-related issues is lacking. In order to raise PSTs with a sustainable worldview in energy and other environmental issues, the extent of their awareness should first be determined. Then, based on the results, suggestions for education policy can be presented.

Second reason, the studies show that awareness is related to environmental attitudes. Accordingly, individuals whose awareness is high in environmental issues have positive attitudes toward environment (e.g., Aminrad, Zakariya, Hadi & Sakari, 2013; Ogunbode & Arnold, 2012; Saricam & Sahin, 2015; Steg, et al., 2005). For example, the study of Saricam and Sahin (2015) with gifted students in secondary school in Turkey found that environmental awareness and attitudes are related. In other words, students with high level of environmental awareness have positive attitudes toward environment. Ziadat (2010) suggests that in order to understand the attitudes of people better, the researchers should look into the awareness of people. Based on all these studies, it is assumed that PSTs' awareness of energy-related issues can present evidence to understand their attitudes toward energy conservation.

Another reason, the relationship between the participants' motivation for energy conservation and their awareness about energy problems should also be understood (Deci & Ryan, 1985). Schultz and Ryan (2015) claim that internalization of a particular behavior requires awareness about the consequences of this behavior. In this way, awareness has a role in the regulation of behavior (Schultz & Ryan, 2015). Based on these claims, in the frame of energy conservation context, it can be concluded that when people are aware of energy-related problems, they can easily internalize ECB. Furthermore, being aware of these problems can help individuals, who are motivated extrinsically for energy conservation, set reasons for energy conservation, and these reasons can lead to internalization of the behavior. Therefore, in this study it was believed that investigating PSTs' awareness of energy related problems contributes to a sophisticated understanding of ECB and its relationships with other intended variables.

The final reason is that awareness has also a role in shaping pro-environmental behavior (Leal Filho, Manolas & Pace, 2009; Kollmus & Agyeman, 2002; Steg & Vlek, 2009). There are some studies supporting the role of awareness in the explanation of pro-environmental behavior (e.g., Brounen, Kok & Quigley, 2013; Dal, Alper, Ozdem-Yilmaz, Ozturk & Sonmez, 2015; Nordlund & Garvill, 2003).

For instance, Zsoka et al. (2013) showed that college students with high level of awareness are more willing to pay more money for the environmentally friendly products. Furthermore, that study compares high school and college students in terms of their awareness about the relation between consumption and environmental issues and their pro-environmental behaviors. The study showed that college students are more aware of the connection between consumption and environmental issues and have more pro-environmental behaviors. There are also studies concerning the awareness of householders. The study of Brounen et al. (2013) showed that householders, who are aware of their residential energy consumption, consume less gas. However, some studies showed that an increase in awareness does not guarantee an increase in pro-environmental behaviors (Csutora, 2012; Kollmus & Agyeman, 2002). Some studies claiming the gap between awareness and pro-environmental behavior emphasized the role of direct experience. Direct experience has a considerable influence on environmental behavior (Korhonen & Lappalainen, 2004; Rajecki, 1982). At this point, awareness, which is gained through personal experience, can have a role in pro-environmental behavior (Chawla, 1998; Tanner, 1980); that is students observing the environmental problems or experiencing these problems as a part of their life have a higher awareness about these problems. Environmental education, which leads to this awareness among students, can stimulate environmentally friendly behaviors (Van Petegem et al., 2007).

Shortly, according to above-mentioned studies in the literature, it can be assumed that awareness of energy-related problems of PSTs can contribute positively to have potential to explain their ECB. In this current research, in order to investigate their awareness, interviews were conducted with PSTs in order to reveal their awareness about this issue. By considering the previous reasons for including awareness into the study, the evidence derived from the qualitative data contributed to explain the observed relationships in the model offered for the current study.

In this present study, the awareness of PSTs was investigated through interviews, which is a tool for qualitative research. The reason for inquiring their awareness

with qualitative research method is threefold. First, listing energy-related problems would make the questionnaire, used in the quantitative part of the study, longer. Second, presenting these problems to the participants can raise an instantaneous awareness. This means that an individual may not have awareness for this issue beforehand, but reading a statement can stimulate this awareness for a moment. In this situation, differentiating if awareness already exists in this person or if the statements cause this awareness would be very difficult. Third, interviews can provide an in-depth understanding about their awareness and they provide further evidence to explain the observed relationships in the model. Furthermore, in this way, the opportunity to express their own views and awareness freely were given to PSTs. This opportunity would have been missed with the quantitative approach. As a representative example, which supports the argument of using qualitative approach for investigating awareness, the study of Van Petegem et al. (2007) make some suggestions about the method for further studies. That study looked into the awareness of pre-service teachers about environmental education through quantitative data. As a limitation, the study indicated that the responses in the survey might be biased and that the participants might give desirable answers. In order to attain more accurate information from the participants, mixed method is suggested in this study. By considering the suggestion highlighted in Van Petegem et al. (2007), awareness about energy-related problems was investigated through qualitative research in this present study. The following section is devoted to the significance of the study.

1.6 Significance of the Study

There are primarily three reasons for conducting this present study. First, Carbon dioxide (CO₂), as a type of greenhouse gases, is accepted as one of the important factors in global warming, and consumption of fossil fuels is the major source for the increase of CO₂ in the atmosphere (US GCRP, 2009). Therefore, decreasing the

amount of CO₂ is a strategy for climate change mitigation (IPCC, 2014). Energy conservation helps to decrease CO₂ since the worldwide main energy resource is still fossil fuels (Hinrichs & Kleinbach, 2013). Schools have a pivotal role in raising awareness for energy conservation and in attaining energy conservation behavior (Bodzin et al., 2013). Accordingly, science education courses, which stress energy resources, energy generation, energy consumption and energy conservation, can support students to acquire energy conservation behaviors (Bodzin, 2012; Bodzin et al., 2013; DeWaters & Powers, 2011b). In addition to science courses, teachers, as a role model, can have an influence on the personality of students (Stanisic & Maksic, 2014). In other words, students' particular behaviors (e.g., pro-environmental behavior) can be influenced (Chawla, 1998). Therefore, it is assumed that science teachers' energy conservation behavior (ECB) is also important. Consequently, as prospective teachers, investigation of pre-service science teachers' ECB is crucial. In addition to this, investigating the variables, and explaining ECB is also critical in order to understand how to support this behavior. The second reason for conducting this study is that investigating behaviors is a complex issue and many theoretical models have been suggested to explain particular behaviors (Kollmus & Agyeman, 2002; Stern, 2000). ECB is also complex in nature and some theoretical models (e.g., theory of planned behavior, norm-belief theory) were suggested to explain it, and these models are successful to some extent. The previous models (e.g., theory of planned behavior, norm-belief theory) were not used in this study because these models present limited explanations regarding why people perform a particular behavior. In this study, self-determination theory (SDT), a motivation theory distinguishing reasons carefully, is used in the current study in order to provide more information regarding the motivation behind the behavior (Darner, 2009). There are few studies investigating ECB through SDT (e.g., Cheung et al., 2016; Sweeney et al., 2014; Webb et al., 2013). However, these studies are conducted with householders and the age of participants shows a variety. The present study is conducted with PSTs and it is believed that results attained from this present study will contribute to teacher education literature and to the education policy of PSTs.

The third reason why the study is carried out is that awareness of energy-related problems of PSTs can provide evidence for the reasons behind the observed relationships in the path analysis. Furthermore, the literature does not include any study, inquiring qualitatively about the awareness of energy related problems of PSTs. There are few studies on the perceptions of students about environmental problems, which investigates these perceptions qualitatively (e.g., Gwekwerere, 2014; Negev, Garb, Biller, Sagy & Tal, 2010). For instance, the study of Negev et al, (2010) described the perceptions of 12th grade students in Israel. The main environmental problems that are specified by the students were solid waste and air pollution. The authors found that students, who had sophisticated answers for environmental problems had more pro-environmental behavior. In terms of ECB, the present study would provide evidence about how much PSTs are aware of energy related problems. Moreover, this study will shed light onto PSTs' energy-related awareness attained through personal experiences and information gained from the courses taken during the university education. Moreover, this study will discover if awareness in this issue has a role in their ECB. As mentioned before, pro-environmental behaviors are complicated and new perspectives for understanding these behaviors can provide evidence to education policy makers. Investigating PSTs' awareness of energy-related problems can provide a new perspective to environmental education. In this respect, this present study can introduce evidence, which can offer suggestions to the policy makers in environmental education.

CHAPTER 2

LITERATURE REVIEW

In this chapter, the related studies in the literature were examined and presented. Energy related problems and issues are explored within environmental education and with a sustainable view. Therefore, the chapter starts with the introduction of the history of environmental education (EE) regarding teaching and the common teaching methods used in EE context. In this respect, field trips, case study and argumentation teaching methods are discussed since these methods are commonly suggested in the instruction of energy related problems and issues. As the study was conducted with preservice science teachers (PSTs), and their courses related to environment might contribute to explanation of the proposed relationships in the model and their awareness of energy related problems and issues, their education program is presented shortly by considering EE context. Then, illustrative attempts to promote energy education are involved under the title of energy education. Followed by this, studies throwing light on the relationships proposed in the model are displayed. Finally, studies regarding the role of awareness in the explanation of ECB and its relationship with motivation and attitude are exemplified.

2.1 Environmental Education

The development of environmental education (EE) gains an acceleration during 1970s, and it owes this improvement to the acts such as the Wilderness Act of 1964 and the Clean Air act of 1965. Although these movements did not request an environmental education, they raised the awareness of people about environmental

problems and issues (Carter & Simmons, 2010). The request for formal and informal environmental education was voiced for the first time in the United Nations Conference held in Stockholm in 1972. Then, the objectives of EE were discussed, and a framework for it was suggested in an international workshop held in Belgrade in 1975 and it was declared as Belgrade charter. However, this framework was brief and it is not clear enough for educators (Hungerford et al., 1980). In order to close this gap, an intergovernmental Conference on Environmental Education held in Tbilisi in 1975. This conference is accepted as a milestone since the famous Tbilisi declaration was accepted. This declaration involves objectives of EE. Differently from the Belgrade chart, Tbilisi defined them in a concrete way (Palmer, 1997). These objectives included the description of (a) awareness of environmental problems, (b) knowledge about environment and the problems related with it, (c) attitudes toward environment and its protection, (d) skills for identifying environmental problems and its solutions, and (e) participation in the solution of environmental problems (UNESCO/UNEP, 1978). By these objectives, problem-solving skills with critical thinking in active participation of students in identifying problems and participation in solutions are emphasized (Hungerford, 2009). Differently from the previous nature and protection education movements, the rhetoric of environmental education is evolved with Tbilisi declaration from understanding the nature and increase knowledge into an intellectual task, which appraise a moral development and commitment to act based on one's values for environmental problems and issues (Stevenson, 2007). Besides, the role of EE in the increase of subject knowledge in environmental problem and issues is emphasized in some studies. For instance, the study of Carlson and McGee (1997) indicated that the interest of high school students' in environmental issues is increased with an environmental science course. In this course, students were actively involved in the scientific process of exploration of environmental issues with a scientific community, and they worked on scientific data. Students drew interpretations from data and reached conclusions about environmental issues. At the end of the study, students' interest in environmental issues was increased dramatically. The researchers emphasized on the important role of being actively

involved in scientific concepts in environmental understanding and the interest in environmental issues (Carlson & McGee, 1997). As exemplified in this study, science education and environmental education is associated in many contexts. That is subjects related to environment (e.g., ozone layer, climate change) overlap with subjects in science education. Indeed, some authors suggest that science literacy should involve ethical and moral concerns regarding the sustainability of world. In this sense, environmental issues should be integrated through critical thinking on scientific claims (e.g., Carter, 2008; Choi, Lee, Shin, Kim, & Krajcik, 2011). Yet, resources and materials have been developed in U.S, which combine environmental education and science education. For instance, Project Learning Tree and Project Wild Life in Learning Design were developed by organizations to support formal and informal educational instructions (Winther, Sadler & Saunders, 2010).

Throughout the evolution in EE, it is understood that awareness of environmental problems and issues reflecting global socio scientific issues (e.g., climate change) and active involvement in society should be included in science literacy (Chiu & Duit, 2011; Hodson, 2003). In order to reflect this view through a pedagogical view, Palmer (1997) proposed a framework for environmental education. It is called *education about, in and for the environment*. In this frame, *education about environment* refers to conceptual knowledge of environment, which is stemmed from the disciplines such as biology, geography and geology. *Education for the environment* stands for developing concern for the environment. Lastly, *education in the environment* is related to be in environment or nature as a learning environment in order to interpret and appreciate the environment with experiencing field. Within this framework, Palmer emphasizes three elements: (a) gaining personal experience in the environment (b) raising environmental concern and (c) undertaking action behavior for the good of environment. Palmer (1997) stressed the critical importance of human dimension in teaching of environmental issues. While introducing this framework, the role of human in environmental change should be emphasized in all steps in this framework. Otherwise, EE content would not be different from other subjects in the curriculum.

2.2 Environmental Education in Science Teacher Education Program in Turkey

The Council of Higher Education in Turkey prepared the list of courses for all education programs with their content. In Science education program, the courses are classified under three categories: (a) solid science (e.g., Basis Physics I, General Chemistry II) and science education courses (e.g., Nature of Science and History, Environmental Sciences, Genetics and Biotechnology), (b) educational sciences courses (e.g., Introduction to Educational Sciences, Instructional Principles and Methods, School Experience) and (c) general culture courses (e.g., History of the Foundation of the Turkish Republic in the Light of Kemal Atatürk's principles, Foreign Language) In addition to this, three elective courses are offered in the program. The content of the courses are described by subject titles.

Regarding Environmental Education (EE), science education program in Turkey does not offer any course, which meets the EE standards. There is a course namely Environmental Sciences courses. The content of this course covers various topics related to environment such as biodiversity, water/soil/air/radioactive pollution and population. In this program, EE is shown as a sub-topic rather than a discipline, and sustainable development is listed as a topic as well. There are some other courses in the program such as Special topics in Biology, Special topics in Chemistry and Special topics in Physics, which can involve environmental problems. However, the program is not detailed enough regarding the topics and the objectives to understand if these courses are offered through EE approach. Therefore, the aim and the objectives of the courses may show a great deal of variation according to the universities and instructors. Furthermore, the elective courses may reveal a considerable diversity among universities. To sum up, PSTs do not experience a formal education for EE or sustainability in this program. Yet, researchers from Turkey such as Kilinc and Aydin (2013), Sahin (2008) and Yildirim (2015) supported this view. Although the science education program is inadequate about

EE and sustainability approach, PSTs have various concepts related to sustainability. The study of Kilinc and Aydin (2013) showed that while PSTs were defining sustainable development, they used various concepts such as politics, economy and education. Among the concepts, environment was the most mentioned concepts.

2.3 Energy Education

In order to construct a sustainable world, we need to reorient the all-level of education in a way to focus on the learners' knowledge, skills, attitude and action, which are in harmony with an environmentally sustainable worldview (Zhou, 2015). To be able to support the sustainable world, energy related problems and issues are one of the important context within environmental education (EE) (Bloom, Fuentes, Holden & Feille, 2015). Energy related problems and issues are complex in nature and they are local in some degree and global. They are local in terms of the energy policies implemented in countries (Harris & Roach, 2013; Tietenberg & Lewis, 2015). For example, in Germany the country decided to shut down the nuclear energy power plants gradually, and the country aims to generate most of its energy from renewable energy in the future as an energy policy. The application of decision is accelerated after the Fukushima disaster (Rehner & McCauley, 2016). Some authors (e.g., Renn & Marshall, 2016) attributed this policy to the role of Green Party in Germany. That is, this party is strong in the parliament and insists on proenvironmental policies like improvement of renewable energy resources. On the other hand, in China, the consumption of fossil fuels is largely used in industrialized production, and the country lives serious air pollution problem locally. However, CO₂ emissions released from this country contributes to global climate change, which affects the whole world globally (Liu & Li, 2011; Xie, Yu, Wang & Liu, 2017). As exemplified, energy related issues are complex and they have multiple dimension such as society, policy, environment and

economy. This feature is parallel with the nature of sustainability. That is, it has three major dimensions: Environment, economy and society (UNESCO, 2005). In order to support the sustainability of world and contemporary EE, these dimensions should be considered in energy education.

One of the earliest programs specific to energy belongs to Coon and Alexander (1976). The authors developed a source book for K-12, which includes activities specific to energy. Various activities (e.g., energy production, energy conservation, types of energy resources) are included into the book. Another source book was developed by Ayers (1981) for 4th to 6th graders. This book adopted energy topic as an interdisciplinary approach, in which this topic is linked to science, math, art, health, and social sciences. Parallel to this approach, Champagne and Klopfer (1977) argued that energy topic influenced from multidiscipline. Therefore, they further claimed that teachers should link this topic to science, economics, sociology, environment and political science. Pattison (1978) also supported the view that energy education is interdisciplinary in nature, and therefore should include history, economics, industrial arts, sciences and home economics. As a current example, KEEP is an ongoing project launched in 1993 by Wisconsin Center for Environmental Education in U.S. KEEP is an energy education program, which aims to improve energy literacy in K-12 through teacher education. An interdisciplinary approach is followed in the content of this program that emphasize the consequences of energy use, production, consumption and management of energy resources to society and environment (KEEP, 2003). According to a current report, prepared for evaluating the 20 years of KEEP project, an increase in ECB of teachers was observed. Moreover, teachers' view on the priority of energy education in K-12 also changed positively (KEEP, 2016).

Energy matters project, which was carried out between 2000 and 2003 in U.K is an example from Europe. The purpose of the project was to raise awareness of energy conservation and reduce the energy consumption at home. To this end, teachers were trained in this program. The program was designed based on education for sustainable development by considering the National Curriculum. According to the

report of this program, 86% of teachers told that they would continue to use this education program in their school (Hejine, 2003).

Another example is EnverIpab project, which is supported monetarily by European Union and conducted between 2008 and 2009. The aim of the project was to increase public awareness of energy efficiency in buildings. To this end, activities for students and a guidance book for teachers were developed within the framework of this project (EnverIpab, 2008).

There is evidence in the literature that energy education has a role in raising awareness in energy conservation and supporting ECB (Morrisey & Barrow, 1984). As mentioned above, these education programs are successful, and projects like KEEP still maintain their teacher training programs in order to raise awareness of energy related issues and improve ECB. In addition to education programs, there are also variables explaining ECB and investigating these variables are important while shaping education programs and environmental settings in classroom. Therefore, the next sections are devoted the variables (i.e., attitudes toward energy conservation, self-determined motivation and awareness of energy-related problems) used in this study to explain ECB of PSTs.

Related with energy conservation, education programs involving climate change education, which address mitigation and adaptation strategies, are important for a sustainable world (Blum, Nazir, Breiting, Goh & Pedretti, 2013; UNESCO, 2010). In order to success it, teaching approaches with an innovative approach (e.g, interdisciplinary approach, science education) in both formal and informal education, which target building awareness of climate change is needed (UNESCO, 2010). As an interdisciplinary approach, Science, Technology, Engineering and Math (STEM) approach can be addressed in here. STEM approach is also included in the current draft of science education program in Turkey (Ministry of National Education [MoNE], 2017). By considering the interdisciplinary nature of STEM approach, it can be integrated into climate education successfully.

2.4 Attitude toward Energy Conservation

One of the objectives stressed in Tbilisi declaration is attitudes as mentioned in the historical development of environmental education. This objective focuses on helping people to obtain several particular values, concerns and motivation for participating in the solution of environmental problems. Many studies were carried out in order to investigate the relationship between environmental attitudes and pro-environmental behavior regarding the definition and dimensions that the study accepted (e.g., Chan, 1996; Gadenne et al., 2011; Glasman & Albarracín, 2004; Hines et al., 1987). The studies indicate that the relationship between attitudes and pro-environmental behavior shows a variation a low level of small relationship to a high one. Below, firstly studies investigating general environmental attitudes and pro-environmental behavior are exemplified. Then, specific examples, which explain the relationship between attitude and energy conservation behavior (ECB), are presented.

The meta-analysis of Hines et al. (1987) is the first meta-analysis study investigating pro-environmental behavior. Among 380 studies, 128 studies were included in the analysis. This meta-analysis was concluded with three major categories of variables (i.e., cognitive variables, psychosocial variables, and demographic variables), which had a relationship with pro-environmental behavior. Attitude is a psychosocial variable in this study, which had a moderately positive relationship ($r = .347$, $SD = .224$). This study was replicated by Bamberg and Moser in 2007. In the first step, 163 papers were identified for the study. However, 46 papers met the criteria of meta-analysis and the authors conducted the study with these papers. The results were in parallel with the study of Hines et al. (1987). In terms of attitudes, a moderate correlation ($r = .42$, $p < .05$) was found with pro-environmental behavior.

As an example to current studies, Boubonari, Marcos and Kevrekidis (2013) investigated the relationship between environmental attitudes and behavior related

to marine pollution with 445 Greek pre-service teachers. This study differentiates two types of behaviors. One is individual action (e.g., recycling paper, plastic, or/and glass, reading articles or/and watch programs on the T.V. related to marine conservation) and the other is collective action behavior (e.g., encouraging local officials to build better sewage treatment plants, taking part in campaigns for prevention of marine environmental damage, such as demonstrations). The analyses showed that the majority of participants had positive attitudes toward the environment. Moreover, the correlation between attitude toward environment and individual action was found as weak ($r = .235$, $p < .001$). Similarly, a weak correlation was found between attitude toward environment and collective action ($r = .114$, $p < .05$). These results revealed that pre-service teachers are more comfortable with displaying behavior at the individual level than exhibiting collective actions.

Another example is the study of Negev, Sagi, Garb, Salzberg and Tal (2008) conducted with 6th ($n = 1.591$) and 12th grade students ($n = 1.530$) in Israel. Environmental literacy of participants was investigated in this study. As a component of environmental literacy, students' environmental attitudes and behaviors were examined. Attitude was measured by a cluster of statements (e.g., Everyone can influence environmental quality; I enjoy being in nature; The environment should be high on the agenda). In order to measure behavior, 10 items were used (e.g., talking about avoiding excessive packaging, recycling, writing letter or sign a petition, saving electricity). Both attitude and behavior variables were unidimensional in the study. The majority of students' environmental attitude was positive. In terms of pro-environmental behavior, 6th grade students' scores were higher than those of 12th grade students except for saving electricity. It was concluded that children engage less in pro-environmental behavior as they grow up. As an alternative explanation, the authors concluded that 6th grade students may enjoy displaying proenvironmental behavior more than current 12th grade students. The correlation between attitude and behavior was found as strong ($r = .56$,

$p < 0.0001$) for 12th grade students, and the strength of correlation was found as medium ($r = .3695$, $p < 0.0001$) for 6th grade students.

Similarly, Erdogan (2009) investigates children's environmental attitude and behavior in the context of environmental literacy. The sample was 2,412 fifth grade students from public and private schools in Turkey. Attitude was measured with five items (e.g., People should give the importance to the environment; Wild animals like snake and owl should not be killed because they also have a right to survive; Natural resources should be carefully used). Behavior was measured with five factors (i.e., eco-management, political action, consumer & economic action, and individual & public persuasion) including 26 items in total (e.g., making specific plans to communicate with national or provincial government officials about the importance of or topics related to environmental protection, taking steps to protect plants, purchasing materials that are recyclable and/or that are made from recycled materials). The results pointed to positive environmental attitudes (raw mean score: 18.04, SD : 3.54). Among four sub-scales of behavior, the highest mean score was obtained from eco-management behavior (raw mean score: 26.51, SD : 6.98). The lowest mean score was observed in political action (raw mean score: 9.42, SD : 11.29), where more than 50% of participants never engaged in any political environmental action. The relationship between attitude and sub-dimensions of behavior was also examined in this study. Findings in the relationship between attitude and behavior types revealed positive and weak relationship with eco-management ($r = .16$, $p < .001$) and economic action ($r = .16$, $p < .001$). The relationship between attitude and political action was found as negative and very weak ($r = -.08$, $p < .001$). Finally, the relationship between attitude and persuasion was insignificant.

As a more recent study, Zhu (2016) investigated the relationship between attitude and pro-environmental behavior with 464 college students from two universities in China. Attitude was measured through the items in NEP and behavior was measured with 20 items (e.g., taking step to reduce energy, encouraging others to recycle or

reuse materials, voting on site or online to support pro-environment governmental officials or decisions). Environmental behavior constitutes four sub-scales (i.e., direct conservation action, consumer/economic action, persuasion, and civic action). The participants displayed a relatively high level of environmental attitude and exhibited a relatively low level of pro-environmental behavior (37.04). The highest score was found on direct conservation action ($M=14.25$). The lowest score was attained from civic action ($M= 3.05$) where only 15% of participants displayed this action. The correlation between attitude and three sub-dimensions of pro-environmental behavior was found as weak ($r=.22$ for direct conservation action, $r=.256$ for consumer/economic action, $r=.161$ for persuasion). Besides, the correlation between attitude and civic action was found as negative and very weak ($r=-.040$).

The relationship between general environmental attitude and pro-environmental behavior was exemplified above. In addition to the use of general environmental attitudes, specific attitudes, such as attitudes toward energy crisis and attitudes toward environmental actions, are used in environmental education (Hines et al., 1987). Attitude toward energy conservation is a specific type of attitude as well. Abrahamse and Steg (2009) who investigated factors relate to energy conservation defined attitudes as follows: “the degree to which a person has a favorable or an unfavorable evaluation of a behavior, and depends on the weighing of various costs and benefits such as financial costs, effort, or time” (p. 712). In this current study, the relationship between attitude toward energy conservation, as a specific type of attitude, and energy conservation behavior (ECB) was investigated. Therefore, studies investigating this relationship are presented below.

In the study of Gadenne et al. (2011), an online survey was used, and 218 people participated in the study. The majority of people were 65 or older in this study. Attitude was unidimensional, and it was measured with four items (e.g., liking the idea of purchasing green, being interested in monitoring and reducing the household's energy use). Items in the attitude scale are related to consuming green products and reducing energy use at home. Energy conservation behavior has three

factors, namely green consumption (e.g., buying recycled toilet paper, buying locally produced goods) recycling (recycling plastic bottles, recycling newspapers) and household habits (turning lights off in unused rooms, using a shower rather than a bath). The results revealed that people with positive attitude toward green products displayed energy conservation behavior related to green consumption, recycling and household habits.

Similarly, the study of Martinsson et al. (2011) investigated ECB and attitudes of households living in Sweden through a nationwide survey covering the period of 2004-2007. Heating and hot water use were examined as energy conservation behavior. General environmental attitude was measured through two different sets of items (i.e., environmental concern and perceived environmental threat) in this study. Then, a dichotomous score was created for attitude, in which 0 represents weak environmental attitude and 1 represents strong environmental attitude. This study examined the relative importance of socio economic status and attitudes regarding ECB. The study showed that environmental attitude had a stronger effect among householders living in apartment blocks when compared with the householders living in detached houses. Furthermore, environmental attitude also had a stronger effect among householders with higher income.

In the study of Abrahamse and Steg (2009), an experimental study that over five months was conducted. The participants in the experimental group were informed about how to conserve energy through direct and indirect energy use. The control group was not informed about this issue. Pre-test was applied to both group before the intervention. Then, the second data collection was conducted five months later the experiment. The number of participants collected data from was 189. The average age mean of the participants was 42.3 and 64% of them was male. Attitude was one of the variables among psychological variables. According to the results, when controlled for treatment group, among the variables, attitude and perceived behavioral control made the highest contribution to the explanation of: $r = .26$, $R^2 = .07$, $F(3, 184) = 4.35$, $p < .01$. Though, the explained variation by psychological variables is very small, socio-demographic variables did not make a significant

contribution to explain energy conservation of householders. Differently from the study of Martinsson et al. (2011), this study shows that energy conservation was more related to affective variables (e.g., attitude, perceived behavioral).

Education is critically important in order to increase attitude and behavior. For instance, Mills and Schleich (2012) conducted a study with 5000 households in 10 countries member to European Union and Norway. It was found out that people with high education level conserved more energy than low education level. However, the relationship between knowledge and behavior was relatively weaker than attitudes. According to these results, the authors stated that attitude is crucial in ECB of households and education has a pivotal role in fostering attitude and ECB.

As exemplified above, attitude toward energy conservation plays an important role in ECB. As another affective variable motivation plays a crucial role in ECB (Kaplowitz et al., 2012; Kobolla, 1984; Mills & Schleich, 2012). Accordingly, attitude and motivation are related with each other. The next section includes information about the motivation theory used in this present study and its relationship with ECB and attitudes.

2.5 Motivation toward Energy Conservation

Motivation studies include the exploration of how to energize and direct the behavior (Deci & Ryan, 1985). There are several motivation theories such as operant theory and attributional theory. The study adopts self-determination theory (SDT) in order to explain energy conservation behavior (ECB) of Pre-service science teachers. This theory was adopted since it uses organismic approach and differentiates motivation types on a continuum basis. Besides, it also focuses on the conditions, which feed intrinsic motivation, and these conditions are named as psychological needs. The following part includes the description of SDT, its

historical development, and exemplifies studies with SDT approach. Then, the represented studies are narrowed to ECB.

2.5.1 Self-Determination Theory

Motivation theories are based on either mechanistic approach or organismic approach. According to mechanistic approach theories, humans are passive organisms, who can be led by environmental stimuli and physiological drives. On the other hand, organismic approach theories accept human as active organisms, who are volitional and initiate the behavior. In other words, this approach assumes that both intrinsic needs and physiological drives have a role in behavior, and the intrinsic needs provide energy to the behavior (Deci & Ryan, 1985). Correspondingly, self-determination theory (SDT) is an organismic theory, which views people as active organism and emphasizes how important intrinsic motivation for human behavior is (Deci & Ryan, 1985; Ryan & Deci, 2017). Indeed, SDT specifically focuses on the psychological level of motivation and differentiates several motivation types (i.e., intrinsic, integrated, identified, introjected, external and amotivation) on a continuum basis. In addition, the theory is peculiarly deal with how social-contextual agents support or foil self-determination of people through basic psychological needs (i.e., autonomy, competence, relatedness). The types of motivation and basic psychological needs are explained and exemplified below within the historical development of SDT.

2.5.1.1 The Historical Development of SDT

SDT considers intrinsic motivation an inherent characteristic of humanity and assumes it as the archetype of psychological freedom or self-determination. (Deci & Ryan, 2011). Six mini-theories (i.e., cognitive evaluation theory, organismic integration theory, causality orientations theory, basic psychological needs theory, goal content theory and relationships motivation theory) together comprise SDT as

it currently stands. The historical development of SDT has been read through these mini-theories, and each of them is explained below. Subsequent to that explanation, a summary for the theoretical framework of SDT is presented.

Cognitive Evaluation Theory

Cognitive evaluation theory is the first mini-theory within SDT, which was developed mainly during 1970s and 1980s. The sole focus of cognitive evaluation theory is intrinsic motivation in that the theory is concerned in the investigation of the impact of events in social environment on intrinsic motivation. This theory assumes that events (e.g., rewards, evaluations, or feedback) have a fundamental role in intrinsic motivation (Deci & Ryan, 1985; 2011; Ryan & Deci, 2017). The theory claims that this influence on intrinsic motivation takes places through the effect of events on one's experience of autonomy or competence, which will enhance or diminish intrinsic motivation (Ryan & Deci, 2017). Cognitive evaluation theory specifically postulates that the events (e.g., rewards) have primarily two functional aspects, namely controlling and informational aspects, which affect intrinsic motivation (Ryan & Deci, 2008). The controlling aspect foils the feel of autonomy, which can lead one to experience the behavior having an external perceived locus of causality (deCharms, 1968, as cited in Ryan & Deci, 2008). By contrast, informational aspect leads one to experience the satisfaction of competence need, which enhances intrinsic motivation (Ryan & Deci, 2017; Ryan & Deci, 2008). Representative studies on the early studies about the effect of different types of rewards on intrinsic motivation are exemplified below.

The first studies about the intrinsic motivation were about the consequence of extrinsic rewards on intrinsic motivation (Deci & Ryan, 2011). One of these examples is the study of Deci (1971). The researcher conducted an experimental study on the effect of money, as an external reward, on intrinsic motivation. College students participated in the study. They were paid for working on an activity, which was a task-contingent reward. This activity was a puzzle since it was observed that many college students worked on the puzzles intrinsically motivated. That study

revealed that intrinsic motivation tended to decrease when the participants were rewarded for the activity. On the other hand, it was found out that intrinsic motivation tended to increase when positive feedbacks and verbal reinforcements were used as external rewards. This study was very important for the understanding about the nature of external rewards. However, the way the reward was administrated is also important for intrinsic motivation. Accordingly, if the reward is informative, it supports the competence or autonomy. On the other hand, if the reward is controlling, it can reduce autonomy. (Ryan, Mims & Koestner, 1983). For instance, in the study of Karniol and Ross (1977) conducted with 57 children whose age were between 4 and 9 years. A decrease in intrinsic motivation was explored with participants, who were rewarded for their ability at an activity without any feedback on their performance. The study of Ryan et al. (1983) supported the result that rewards undermined intrinsic motivation of students. Furthermore, students who received controlling feedback also showed a decrement intrinsic motivation. On the other hand, students who received informational feedback and informationally performance contingent rewards displayed an increase in their intrinsic motivation. In addition, another study showed that if the reward is introduced unexpectedly, the intrinsic motivation is not undermined (Lepper, Greene, & Nisbett, 1973). To summarize, the examples mentioned here present the conditions related to the use of rewards in a controlling way, in which cognitive evaluation theory proposes that these conditions undermine intrinsic motivation (Ryan & Deci, 2017).

Organismic Integration Theory

Cognitive evaluation theory focuses on intrinsic motivation and the effects of events (e.g., rewards) on intrinsic motivation. Subsequent to cognitive evaluation theory, Deci and Ryan started to question if extrinsic motivation could be autonomous in 1980s (Deci & Ryan, 2011). They proposed organismic integration theory, whose primary concern is the explanation of making extrinsic motivation autonomous through internalization process. Based on this processes, types of extrinsic motivation emerge regarding the theory (i.e., integrated regulation, identified

regulation, introjected regulation, external regulation) (Deci & Ryan, 2008; Ryan & Deci, 2000b; 2017). In other words, this theory proposes that extrinsic motivation shows a variety in itself and they differentiate into four types, namely integrated regulation, identified regulation, introjected regulation and external regulation. This differentiation is based on the degree of internalization (Deci & Ryan, 1985; Ryan, Connell, & Deci, 1985). Internalization is transforming external sources, which involves values, beliefs, or behavioral regulations, into one's own. When a behavior is regulated through internalization, the person displays this behavior in the absence of a reward or contingency. The degree of internalization shows a differentiation among extrinsic types of motivation (Ryan & Deci, 2008; 2017). All types of extrinsic motivation do correspond to motivation types (Deci & Ryan, 1985; Ryan & Deci, 2008). Moreover, extrinsic motivation types differentiate from intrinsic motivation in that the basis for internalization is not the interest or the curiosity in the activity, instead, the activity's instrumental importance per se is the main interest (Ryan & Deci, 2008). Most of the behaviors and much learning are not intrinsically motivated, i.e., people do not fulfill them for pleasure. People do some of these behaviors or learning since they find a reason to do it (Deci & Ryan, 2011). This is also a way to regulate and internalize behavior. As mentioned, not all behaviors or learning are intrinsically motivated but when people internalize them into their identity or values, they keep displaying the behavior or learning. For that reason, investigating types of extrinsic motivation and how people internalize them are important for understanding motivation (Deci & Ryan, 2011; Ryan & Deci, 2017).

Organismic integration theory distinguishes four types of regulatory styles, which represent how regulations are integrated into one's own value system. These regulation types are: external regulation, introjected regulation, identified regulation and integrated regulation (Deci & Ryan, 1985; 2011; Ryan & Deci, 2000b; Ryan & Deci, 2008; 2017). These regulation types are defined from non-self-determined type to most self-determined type. As Figure 2.1 shows, intrinsic motivation is self-determined motivation and the degree of self-determination

within extrinsic motivation types increases with getting close to intrinsic motivation. The regulatory types show variation in that they determine the level of internalization of behavior. When the behavior is not internalized, the person is amotivated for act. Amotivation in this context refers that a person has not desire for displaying a certain behavior. The person with amotivation believes that s/he does not have a control on the events in that s/he avoids displaying the behavior or s/he believes that the behavior will not generate the desired results so that s/he is unwilling to perform the behavior (Ryan & Deci, 2017; Ryan & Deci, 2000a). Among the types of extrinsic motivation, the closest to amotivation is external regulation. Further information about extrinsic motivation types and intrinsic motivation is presented below.

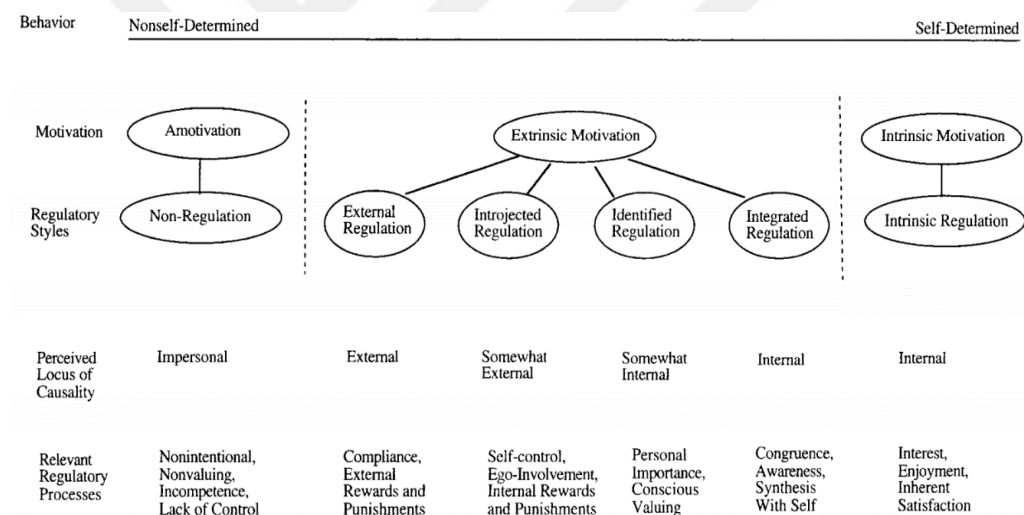


Figure 2.1 The continuum basis of self-determination with locus of causality and regulatory processes (Ryan & Deci, 2000b, p.72).

The first type of extrinsic motivation, external regulation, is the least autonomous type of motivation controlled primarily through external factors such as rewards, punishment, deadlines, and directives. In this type of behavior, the behavior is displayed to meet the external demands (Leagult, 2016). This type of extrinsic motivation was examined in many studies whose theory was based on cognitive evaluation. Furthermore, it is central to operant behaviorism studies (Ryan & Deci,

2008). People generally experience this motivation type as controlled or alienated (Ryan & Deci, 2000b), and they perform the behavior since a separable consequence is expected. Powerful rewards or punishments can lead the behavior. However, the major problem associated with external regulation is that the behavior is not sustained over time such that the behavior tends to disappear in the absence of rewards and punishments (Ryan & Deci, 2017). An example to external regulation is that a child may do homework in order to get praise from the teacher (Ryan et al., 1985).

The second type of extrinsic motivation, introjected regulation, is greater regarding the internalization degree of introjected regulation than external regulation in the continuum basis within SDT (Deci & Ryan, 1985). This type of extrinsic motivation is regulated through affective and external incentives within the person. Furthermore, Ryan & Deci (2017) emphasize on the role of self-esteem contingency and projection of self-approval and self-disapproval on others in introjected regulation. This means that a person with this type of motivation regulates his/her behavior regarding the feeling of worth, which is imagined as approval or disapproval of others, and regarding the judgement of oneself as feeling of pride or shame. For example, a person with introjected regulation performs a behavior in order to not feeling guilty or performs the behavior in order to feel the sense of worth in society. As the examples show, the perceived locus of causality in introjected regulation is external. Therefore, introjected regulation is controlled through individuals' internal judgements (Ryan & Deci, 2017). If a student, from pervious example, has introjected regulation for doing homework, s/he may do it to receive general approval or s/he may feel guilty or unworthy if s/he does not do her/his homework. The next extrinsic type of motivation is identified regulation. The degree of internalization and self-determination of behavior in identified regulation is more than in introjected regulation Deci & Ryan, 1985; Ryan & Deci, 2000a; Ryan & Deci, 2000b). Besides, different from introjected regulation, the regulation in identified regulation is not controlled; instead, it is self-regulated (Legault et al., 2007). Identification is described as a conscious endorsement of

values of a behavior or a goal, which is critically important to one. Therefore, one with identified regulation will say s/he perceives the behavior as personally important (Ryan & Deci, 2017; Ryan & Deci, 2000a; Ryan & Deci, 2000b). Accordingly, when compared with introjected regulation, this regulation is characterized by internal perceived locus of causality (Legault, 2007). For instance, a student with identified motivation does his/her homework since s/he thinks doing the homework is personally important to her/him.

Table 2.1

Types of extrinsic motivation with examples (Legault, 2016, p.3)

Type of Extrinsic Motivation	Nature of External Contingency	Underlying reason for Behavior	Example
External Regulation	Consequences, incentives, compliance	To receive or avoid a consequence; to fulfill an external requirement	“I avoid making prejudiced comments so that other people will think I’m nonprejudiced
Introjected Regulation	Feeling of internal pressure; to avoid guilt or to boost the ego	Because it “should” be done	“I avoid acting in a prejudiced manner because I would feel bad about myself if I didn’t”
Identified Regulation	Personal valuing of a behavior, sense of importance	Because it is important	“I avoid being prejudiced because it is an important goal.”
Integrated Regulation	Expression of self and identity; congruence with self and other values	Because it reflects core values and self/identity	“ I avoid being prejudiced because I see myself as a nonprejudiced person.”

The most autonomous and self-determined type of extrinsic motivation is integrated regulation (Deci & Ryan, 1985; 2001, 2016; Ryan & Deci, 2000a; b; c). Integration of behavior into the self entirely takes place when the behavior is integrated into the person's values and needs. It is a part of person's life. Although integrated regulation and intrinsic motivation share several qualities, integrated regulation is still a type of extrinsic motivation since the behavior is not displayed for pure enjoyment or pleasure (Ryan & Deci, 2017; Ryan & Deci, 2000a; Ryan & Deci, 2000b). A student with identified regulation may do homework since doing homework is a part of his/her identity or it is a part of his/ her life. Types of extrinsic motivation with examples are summarized in Table 2.1

Causality Orientations Theory

The third mini theory within SDT was formulated as causality orientations theory by Deci and Ryan in 1985 in order to describe the individual differences in motivational orientations in detail. Three orientations are specified namely, autonomy orientation, controlled orientation and impersonal orientation (Ryan & Deci, 2008). It is claimed that everyone has each of these orientation types to some degree (Deci & Ryan, 2011).

The autonomy orientation expresses general tendency of people to orient towards internal and external inputs which are autonomy supportive or informational promoting self-determination (Deci & Ryan, 1991; 2011). When the autonomy orientation of a person is high, the person tends to use identified and integrated types of regulation in that the person's intrinsic motivation tends to be high (Ryan & Deci, 2017). Controlled type of orientation elucidates general tendency of people for their orientation toward conspicuous controls and demands at the personal level (Deci & Ryan, 1991; 2011). People in control orientation experience social context regarding rewards and social pressure. They either assent to or revolt against the conditions. By doing so, they mostly lose their own values or interests. When the controlled orientation of a person is high, s/he tends to adopt external or introjected types of regulation and the level of intrinsic motivation is low (Ryan & Deci, 2017).

Impersonal orientation describes general tendency of people toward cues, which indicates incompetence or deprivation of control. People in impersonal orientation often experience amotivation.

Basic Psychological Needs Theory

As a fourth mini theory, basic psychological needs theory was proposed (Deci & Ryan, 1996). The previous mini theories explored how conditions support autonomy, competence and relatedness, which facilitates the regulation process (i.e., internalization and integration of behavior), intrinsic motivation and more autonomy supported causality orientations. Basic psychological needs theory focuses on the relationship between satisfaction of basic psychological needs and well-being. These fundamental needs are important for taking action in an activity as well as well-being. Within this framework, three basic psychological needs are described, namely autonomy, competence and relatedness (Ryan & Deci, 2017; Ryan & Deci, 2000c). Autonomy is related to the desire of one's need to be able to organize his/her behavior by his/her own. Through this way, this person can feel that the actions of her/his are originated from his/her will rather than external forces. By considering this, the satisfaction of autonomy need refers to the sense of feeling of behaving willingly (Deci & Ryan, 2000; Ryan & Deci, 2002). Competence refers to one's need about feeling effective in realizing the desired outcome (Deci & Ryan, 2000; Ryan & Deci, 2002). In other words, it refers to sense of self-confidence rather than the skills or competence (Cooke, Fielding & Louis, 2016). Lastly, relatedness is the need of feeling of being a part of a social group (Deci & Ryan, 2000; Ryan & Deci, 2002).

SDT claims that all three basic needs are interdependent to each other. In most conditions, each need facilitates the satisfaction of other needs. For example, if one is not autonomous in an activity, it is difficult to attain competence satisfaction for that activity. Likewise, if one does not feel competent in an activity, this person probably will not have a powerful feeling of volition or interest to engage in the activity (Ryan & Deci, 2017).

Goal Content Theory

As the fifth mini-theory, goal content theory is outlined within SDT. The major concern of goal content theory is the goals and aspirations in people's life and their relationship with basic psychological needs, motivation and well-being. Two types of life goal are described within this theory, namely extrinsic goals (e.g., fame, wealth, image) and intrinsic goals (e.g., personal growth, relationships, and contribution to community), which are related differently to well-being. Accordingly, a relatively greater importance placed on extrinsic aspirations results in lower levels of well-being, whereas a stronger focus on intrinsic aspirations points to higher levels of well-being. That is, SDT claims that some goals people pursue and which shape their lives will generate satisfaction of psychological needs, while some of them will not (Ryan & Deci, 2017).

Relationships Motivation Theory: The Self in Close Relationships

Relatedness is one of the basic psychological needs within SDT. As the sixth mini-theory, relationships motivation theory concerns the qualities of close relationships (e.g., romantic relationships, friendship) and the relationship between their outcomes and well-being. As mentioned in basic psychological needs mini-theory, autonomy, competence and relatedness are all related with each other. Relationship motivation theory specifically focuses on the relationship between autonomy and relatedness in close relationships. Indeed, it is claimed within SDT that the relationship between these two psychological needs is intricately related and satisfaction of these needs can result in well-being. Accordingly, the satisfaction of each need is interlaced with satisfaction of the other, and this outcome influences the well-being of each couple. This theory is also used in parent-child relationships regarding attachment (Ryan & Deci, 2017). This topic and this mini-theory within SDT are out of this study. Therefore, the literature specific to this topic is not included in here.

2.5.1.1.2 Self-Determination Theory in Environmental Education Context

Self-determination theory (SDT) has been studied in many life domains (Ryan & Deci, 2017). To illustrate, the domains of schools and learning (e.g., Gillet, Vallerand, & Lafrenière, 2012; Gorozidis & Papaioannou, 2014; Niemiec & Ryan, 2009; Reeve, 2012); workplace motivation (e.g., Deci, Olafsen, & Ryan, 2017; Fernet, Austin, Trépanier, & Dussault, M., 2013; Van den Broeck, Vansteenkiste, Witte, Soenens, & Lens, 2010); sport and exercise (e.g., Dutra, 2015; Standage & Ryan, 2012); health care and psychotherapy (e.g., Ryan, Patrick, Deci, & Williams, 2008; Ziviani & Poulsen, 2015); cultural and religious socialization (e.g., Ryan, Rigby, & King, 1993); and virtual worlds (e.g., Ryan, Rigby, & Przybylski, 2006) can be listed. Among these various dimensions, a limited number of studies have focused on the environmental education context. For example, the study of Green-Demers et al. (1997) investigated the relationship between SDT and environmental behavior. Similarly, De Groot and Steg (2010) explored the relationship among value orientations, SDT and pro-environmental behavioral intentions. Another study was conducted by Sheldon, Wineland, Venhoeven, and Osin (2016) with environmental activists, in which SDT is used in order to understand the participants' commitment to activism. Parallel to this study, Cooke et al. (2016) also investigated the role of self-determined motivation and basic psychological needs in activist people' pro-environmental behavior. In addition to these survey studies, experimental studies were conducted in educational settings to figure out how SDT works in environmental education related classes. The study of Osbaldiston and Sheldon (2003), Darner (2012) and Karaarslan et al. (2013) can be presented as examples. All these studies are explained and summarized below.

One of the earliest studies was carried out by Green-Demers et al. (1997). This study investigates the relationship between the level of self-determination and pro-environmental behavior. The study examined recycling, purchasing environmentally friendly products and educating oneself as to what can be done for environment as pro-environmental behavior. The study was conducted with 444

university students. It was revealed that self-determined motivation and all three types of environmental behaviors are positively related ($r: .38$ for recycling, $r: .43$ for purchasing environmentally friendly products and $r: .52$ for educating oneself as to what can be done for environment as pro-environmental behavior, $p < .01$). This study supported the relationship between self-determined motivation and pro-environmental behavior such that when people have self-determined motivation, it is more likely that they display pro-environmental behavior.

Similarly, the findings of the study by De Groot and Steg (2010) provide ample evidence on how more self-determined people show pro-environmental behavior. Besides self-determined motivation types, the study investigated the relationship between value orientations (i.e., egoistic, altruistic and biospheric) and pro-environmental behavior. This study included two studies which implemented the same instruments in different order. The authors conducted Study 2 in order to understand if the order effect influences the results. Study 1 was conducted with 304 university students, and Study 2 was conducted with 520 university students. Two types of environmental behaviors were defined as pro-environmental behavior. These are choosing a car based on environmental performance and the intention to donate to an environmental organization. It was found that intrinsic motivation (study 1, $r = .24$, $p < .01$; study 2, $r = .30$, $p < .01$), integrated regulation (study 1, $r = .21$, $p < .01$; study 2, $r = .30$, $p < .01$), identified regulation (study 1, $r = .13$, $p < .05$; study 2, $r = .31$, $p < .01$) and introjected regulation (study 1, $r = .18$, $p < .01$; study 2, $r = .29$, $p < .01$) were significantly and positively related to car preference based on environmental performance. By contrast, there was not a significant relationship between external regulation and car preference based on environmental performance (study 1, $r = .05$, $p > .05$; study 2, $r = -.08$, $p > .05$). Furthermore, a negative relationship was found with amotivation (study 1, $r = -.21$, $p < .01$; study 2, $r = -.25$, $p < .01$). In terms of intention to donate to an environmental organization, positive and significant relationship was found with intrinsic motivation (study 1, $r = .37$, $p < .01$; study 2, $r = .35$, $p < .01$), integrated regulation (study 1, $r = .26$, $p < .01$; study 2, $r = .33$, $p < .01$), identified regulation (study 1, $r = .23$, $p < .01$; study 2, $r = .28$,

$p < .01$) and introjected regulation (study 1, $r = .27$, $p < .01$; study 2, $r = .26$, $p < .01$). On the other hand, the correlation with external motivation was found insignificant (study 1, $r = .07$, $p > .05$; study 2, $r = -.05$, $p > .05$) and the correlation with amotivation was found significantly negative (study 1, $r = -.18$, $p < .01$; study 2, $r = -.09$, $p < .05$). Besides correlation analysis, hierarchical regression analysis was conducted in order to reveal how much variance of pro-environmental behavior was explained by self-determined motivation types and value orientations. It was found that car preference was explained by self-determined motivation types with 8% of variance ($F(6, 294) = 4.44$, $p < .001$) in Study 1 and 17% ($F(6, 513) = 17.01$, $p < .001$) of variance in Study 2. However, all self-determined motivation types did not contribute to the explanation of pro-environmental behaviors in both Study 1 and Study 2. In Study 1, only intrinsic motivation ($\beta = .17$, $t = 2.01$, $p < .05$) and amotivation ($\beta = -.18$, $t = -2.39$, $p < .01$) significantly contributed to the explanation of car preference but in Study 2, only intrinsic motivation ($\beta = .05$, $t = 3.98$, $p < .01$) contributed significantly to the explanation of this behavior. In terms of the explained variance in intention to donate, self-determined motivation types accounted for 14% of variance in Study 1 ($F(6, 290) = 8.05$, $p < .001$) and 16% of variance in study 2 ($F(6, 513) = 15.70$, $p < .001$). In Study 1, only intrinsic motivation contributed to the explanation of intention to donate ($\beta = .33$, $t = 3.98$, $p < .01$). In study two, intrinsic motivation ($\beta = .17$, $t = 2.79$, $p < .01$), integrated regulation ($\beta = .18$, $t = 3.23$, $p < .01$) and external regulation ($\beta = -.13$, $t = -2.44$, $p < .05$) contributed to the explanation of intention to donate. As the results showed, the findings were inconsistent regarding the explanatory power of self-determined motivation types. The authors explained this inconsistency with the high correlation among self-determined motivation types. This high correlation is a common characteristic described in SDT (Pelletier et al., 1998; Ryan & Deci, 2017).

In addition to these studies conducted with college students, studies were conducted with environmental activists in order to understand their motivation for environmental behavior and the relationship between SDT and pro-environmental behavior. One of these studies was conducted by Cooke et al. (2016) with two

samples ($N_1=261$; $N_2=320$). The participants in both sample were selected purposively, who are environmentally active people and have lower-impact lives. Two types of environmental behaviors are described, namely easy pro-environmental behavior and difficult pro-environmental behavior. Besides, carbon footprint of participants was included in the study. To illustrate, the following examples were used as items for easy proenvironmental behaviors: switching off the computer when it is not in use, hanging up washing on a clothesline instead of using a dryer, only using the washing machine when it is full. The following examples were used as items for difficult proenvironmental behaviors: participating in marches or protests about environmental issues, donating money to environmental organizations, talking to friends and family about environmental issues. Carbon footprints of participants were estimated considering their flight travel and diet. The results attained from Sample 1 and Sample 2 parallel to each other. However, carbon footprint was included only in Sample 2. Therefore, only the results attained from Sample 2 are provided in here. A path model explaining the pro-environmental behaviors of environmental activists was proposed in this study and the results for this model are shown in Figure 2.2

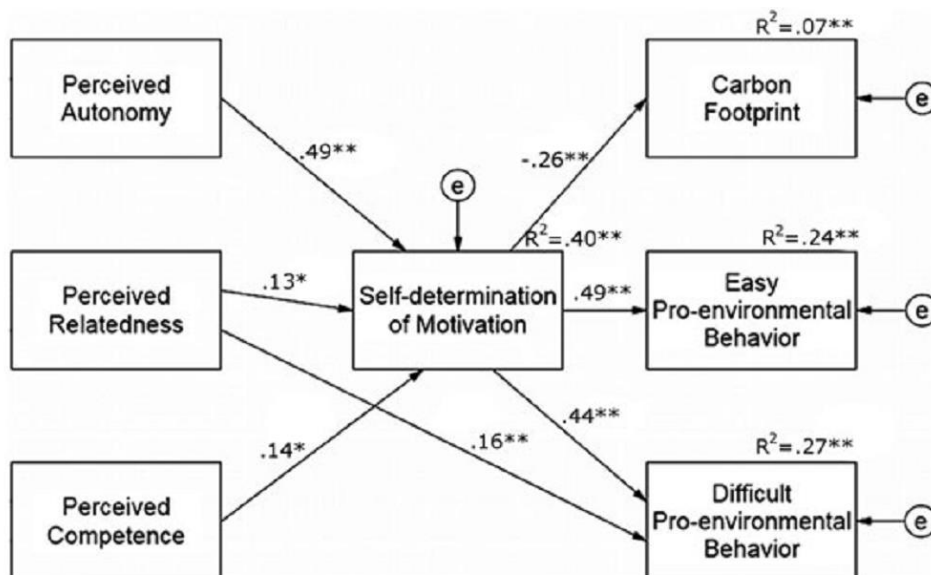


Figure 2.2 The results of path model in the study of Cooke et al. (2016)

The results of the study of Cooke et al. (2016) showed that the highest relationship with self-determination was found in perceived autonomy need. The relationship of self-determination with perceived relatedness and perceived competence was also significant. All these results indicate that the more psychological needs are satisfied, the more self-determined motivation can be attained. The model explained 24% of variance in easy- proenvironmental behavior and 27% of variance in difficult pro-environmental behavior. On the other hand, the variance explained in carbon footprint was relatively very low ($R^2 = .07$). The relationship between self-determined motivation and easy and difficult pro-environmental behavior was found to be fairly high.

As one of the earliest experimental studies regarding SDT in environmental education, the study of Osbaldiston and Sheldon can be a representative example. This study was conducted with 162 university students at Introductory to Psychology class. In that study, the participants received autonomy support from the researchers for pro-environmental behavior. Then, a model, which includes students' perceived autonomy supportiveness, internalized motivation and goal performance, was proposed in order to predict the future intentions of participants' pro-environmental behavior. The model is a linear model in which perceived autonomy support predicts internalized motivation, internalized motivation predicts goal performance, and goal performance predicts future intentions of pro-environmental behavior. This path model and path coefficients (β) were shown in Figure 2.3 below. The fit indices of the model were found to be good, which means the data fit the model (CFI=0.98, NNFI=0.98, CI=0.98, RMSEA: 0.03).

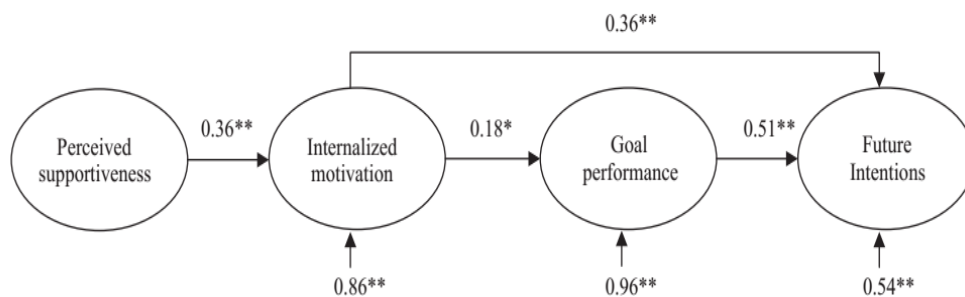


Figure 2.3 The path model proposed in Osbaldiston & Sheldon (2003) and results obtained from that study

As Figure 2.3 shows, students' perceptions regarding the researchers' autonomy support influence the students' internalized motivation, and their internalized motivation, in other words their self-determined motivation, influences the future intentions of pro-environmental behavior. This study provides evidences for the teaching settings in that supporting students' autonomy need is critical for their future pro-environmental behavior. The study emphasized that perception of autonomy support may be influenced by personal characteristics.

Another experimental study with SDT was conducted by Darner (2012). The study was conducted in a biology course, which addresses environmental issues. The contents covered in the course were ecological principles, the dynamics in human population, biodiversity, the management of human resource and pollution. Besides content knowledge, laboratory activities and field trips were involved in the course. The researcher formed two groups. One was experimental group with 20 students who were taught with an SDT approach. 15 of them participated in the study. The other was controlled group with 17 students, and 12 of them participated in the study. There were 27 voluntary participants in total enrolled in the study. The same content was taught and both laboratory activities and field trips were involved in both groups. SDT-guided section involved problem solving activities, small group and whole group discussions. Besides, student-guided lecture was provided but it

was limited. Basic psychological needs of students were also taken into consideration in the experimental group. The results revealed that except for amotivation there was no statistically significant difference between groups regarding self-determined motivation types. However, the mean scores of self-determined motivation types, except for amotivation were higher in the experimental group. It was concluded that students in the experimental group experienced a more considerable decrease in amotivation toward pro-environmental behavior than the control group. It was clearly emphasized that SDT-guided instruction had a potential role in decreasing the amotivation toward pro-environmental behavior. The study of Darner (2009) had some limitations. That is elements supporting SDT-guided instruction were not described clearly enough to understand how these needs were satisfied. Therefore, Darner (2012) suggested further studies, which will make distinct how basic psychological needs are satisfied within an SDT-guided instruction. Likewise, the study of Karaarslan et al. (2013) investigated the use of SDT within an environmental science course. Different from the study of Darner (2012), the study is mixed method research and the control group is absent. The study of Karaarslan et al. (2013) was conducted with pre-service science teachers (PSTs) at 4th grade who were enrolled in an environmental science course. PSTs discussed an environmental problem, which was provided by the researcher each week. A focus group with five PSTs was formed and their qualitative data (i.e., assignments, group discussions, interviews and reflections) were analyzed. It was found that when cognitive features (e.g., awareness of personal role in the system, awareness of environmental actions) and instructional features (e.g., student guided discussion, real life connection) were included into the course, basic psychological needs of students can be supported and their motivation was improved for pro-environmental behaviors. Creating a learning environment, which supports PSTs' needs for autonomy, competence and relatedness, not only support their self-determined motivation but also provides a good environmental education example for their professional development. Therefore, this study is critically important in terms of inclusion of SDT approach in teacher education.

2.5.1.1.3 Explaining Energy Conservation Behavior with Self-Determination Theory

Energy conservation includes a good number of activities which vary from curtailing electricity use in household (e.g., turning off the lights when leaving a room) to consuming foods (e.g., buying local foods) (Steg, 2008). In order to differentiate types of energy conservation behavior, such researchers as Abrahamse and Steg (2009); Reinders, Vringer and Blok (2003) and Vringer and Blok (1995) argue that two types energy conservation, which are direct energy use and indirect energy use, should be differentiated in the studies of household energy use. To illustrate direct energy use, examples such as using gas and lights can be listed. Indirect energy use refers to the energy which is embodied in the products and services purchasing by households. For example, consuming local foods help save energy. By contrast, consuming exotic foods results in energy waste since the process of transportation and distribution of these products requires additional energy. (Abrahamse & Steg, 2009). Many studies were not make a differentiation and mainly focused on direct energy use at house (e.g., Ibtissem, 2010; Webb et al, 2013). In order to hinder such a confusion, the items used in the studies are exemplified while exemplifying the literature in this chapter.

Many of the studies investigating energy conservation behavior (ECB) adopted theory of planned behavior (e.g., Clement et al., 2014; Macovei, 2015) and value belief norm theory (e.g., Ibtissem, 2010; Sahin, 2013). These studies were presented below. In addition to these theories, motivation oriented studies were conducted. Self-determination theory, which is a motivation type theory, was also adopted in limited number of studies as well. Subsequent to exemplification of studies with theory of planned behavior and value-belief-norm theory, energy conservation studies with SDT (e.g., Cheung et al., 2016; Sweeney et al., 2014; Webb et al., 2013) are introduced below.

In the study of Ibtissem (2010), 703 people from Tunisia participated the study. ECB of those people were investigated through value-belief-norm theory. ECB was investigated with a survey. The items measuring ECB focused on eco-management behavior and direct energy use (e.g., I wait until I have a full load before doing my laundry; I leave the electric machines on standby mode; I wash dirty clothes without prewashing). A structural model was proposed in the study (see Figure 2.4). The results showed that the goodness of fit indexes of the model was acceptable (GFI= 0.916, AGFI = 0.904, RMR <0.1; RMSEA <0.05). This model explained 5.8% of the variance in ECB.

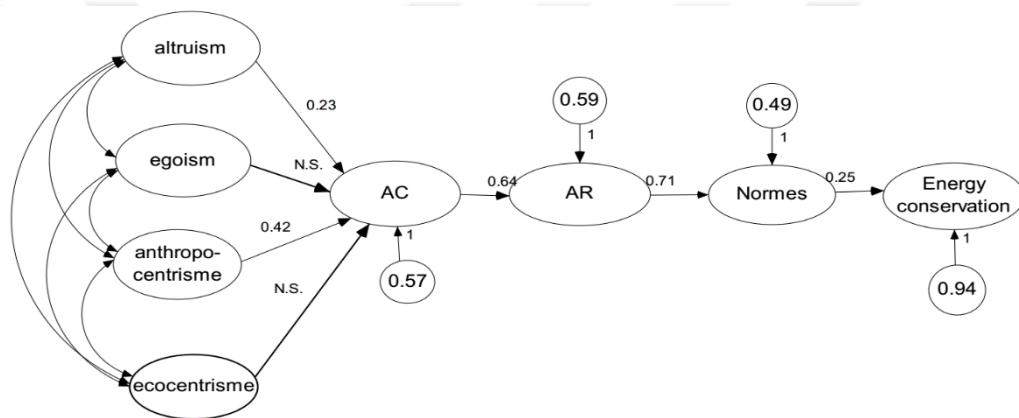


Figure 2.4 The path model proposed in Ibtissem (2010) and results obtained from that study

The results in the study of Ibtissem revealed that the altruistic and anthropocentric values significantly affect the beliefs in the consequences of the individual's energy conservation (respectively, $t = 3.947$, $p < 0.001$; $t = 7.595$, $p < 0.001$). Furthermore, it was found that when a person is more sensitive toward the consequences of energy conservation, that person would feel more responsible for resolving problems related to the energy consumption ($\beta = 0.465$; $t = 12.198$, $p < 0.001$). However, the results showed that egoistic and ecocentric values did not have an impact on the feeling of moral obligation to conserve energy (respectively $t = -1.093$, $p > 0.1$; $t = 0.266$, $p > 0.5$)

Similarly, Sahin (2013) examined the energy ECB of pre-service teachers within the value-belief-norm theory. The sample consisted of 512 pre-service teachers who

were educated in two public universities in Turkey. ECB of participants were measured through a self-reported instrument adapted to Turkish. The items were eco-management behaviors which measured individual energy conservation and direct energy use (e.g., In the winter, I keep the heat on so that I do not have to wear a sweater; I wash dirty clothes without prewashing and at low temperatures; I switch off the lights if I am the last one leaving the room). According to the results of multiple linear regression analysis, value-belief-norm theory was successful to explain ECB of participants in that personal norms, biospheric value orientations and egoistic value orientations were all related to ECB ($R^2 = 0.28$, $F(7,511) = 28.72$, $p < 0.001$). Among these variables, the unique contribution of egoistic ($\beta = -.21$; part correlation = $-.20$) and biospheric value orientations ($\beta = .28$; part correlation = $.17$) to the explanation of ECB was greater than personal norms ($\beta = .18$; part correlation = $.12$). All these variables explained 28% variation in ECB ($F(7,511) = 28.72$, $p < 0.001$).

Self-determination theory has been used in limited number of studies in order to explain ECB. To illustrate, Webb et al. (2013) investigated ECB of 200 respondents whose ages between 18 and 70 years. The participants completed an online questionnaire which includes items for SDT (e.g., saving energy interests me) and ECB (e.g., turning off the lights when not in the room). ECB items are direct energy use items. This study included autonomous motivation and controlled motivation within SDT theory. Besides SDT, this study adapted model of goal-directed behavior for the explanation of ECB. A theoretical model was proposed. The results revealed that the data fit the model well (chi-square = 1.08, $p = 0.78$, CFI = 1, RMSEA = 0.00). The significant paths in the model were between autonomous motivation and intentions ($\beta = .16$) and behavior ($\beta = .37$). The model explained 23% of variation in ECB and 60% of variation in intention. Furthermore, inclusion of SDT increased the explained variation in behavior ($F = 17.91$, $p < .01$).

Similarly, the study of Cheung et al. (2016) incorporated SDT into a model of goal-directed behavior. In this way, the predictive power of the model was improved. The sample of the study consisted of 1004 people who were between the ages of 18

and 70 and living in Hong Kong. Energy conservation was measured with four items (i.e., wearing a thicker jumper in winter instead of turning the heating up, making an effort to use public transportation, selecting energy efficient appliances when purchasing such items, waiting until you have a full washing load before doing the laundry). Three types of motivation, namely intrinsic motivation (e.g., I can have fun when I improve the environmental quality at the right time; Environmental protection is an integral part of my life), extrinsic motivation (I would feel guilty if I did not; Your friends insist that you do so) and amotivation (e.g., Do not know; the environment did not improve; Do not know; I cannot see the result) was measured within SDT. ECB was measured with four items which were eco-management and direct energy use types (e.g., Wear a thicker jumper in winter instead of turning the heating up; Wait until you have a full washing load before doing the laundry). The study with model of goal-directed behavior and SDT proposed a path model to explain ECB of participants. The results showed that the model had good fit indexes (Chi-square/df = 2.724, CFI = 0.954, RMSEA = 0.04). The model explained the 27% of variation in ECB and 49% of variation in intention was explained. The greatest relationships with ECB were found with intrinsic motivation ($\beta=.27$, $p < 0.001$) and extrinsic motivation ($\beta=-.26$, $p < 0.001$). It means that householders internalizing energy conservation conserve more energy and people who are motivated extrinsically and do not internalize energy conservation conserve less energy.

Another study was conducted by Sweeney et al. (2014), which was an experimental study conducted via internet. The study was conducted with 696 householders in Australia. Among the participants, 464 of them were in the experimental group, 232 of those were in the control group. The experiment was an online intervention, which formed an online community in order to create facilities for discussions related to energy conservation issues. Furthermore, weekly newsletters were used in order to maintain regular engagement of experimental group members in online discussion forums. The researchers in this study used online word of mouth term referring to an informal communication arisen among private parties where

products and services are evaluated. The online forums served to word of mouth by discussing energy costs, how to conserve energy and environmental issues. In the study, three types of basic psychological needs, namely autonomy (e.g., I have say in choosing what I do to save energy; I decide what I do to save energy), competence (e.g., I feel confident in my ability to save energy; I feel able to meet the challenge of reducing my energy use) and relatedness (e.g., I feel connected with other people who are saving energy; I feel a sense of camaraderie with other people who are saving energy) were measured. Within SDT, only integrated motivation (e.g., I want to save energy at home because it is a part of the way I have chosen to live my life) type was measured. As outcome variable, ECB (e.g., turning off the lights when not in the room, using energy efficient light bulbs) of participants was measured which were direct energy use and eco-management type of energy conservation. Data were collected at three times. The first is before the introduction of online intervention to the control group (t_0), the second data were collected at the second month of intervention (t_2) and two months later the final data were collected (t_2). In order to comprehend if any significant difference in ECB was obtained as a result of the intervention, a path model was proposed. The results revealed that the model fitted the data well ($\chi^2 = 18.44$, $df = 11$, $p < 0.07$, $\chi^2/df = 1.67$, $RMR = 0.02$, $CFI = 1.00$, $RMSEA = 0.03$). The results showed that the online intervention had a significant and small effect on ECB. The main effect on ECB was previous ECB which was measured before the intervention ($\beta = 0.51$, $t = 12.35$, $p < 0.0$). It means that ECB was largely driven by habit. However, there was evidence that even though the effect of intervention was small, a positive and significant difference was attained (t_1 ; $\beta = 0.07$, $t = 1.98$, $p < 0.05$). Moreover, 27% of variance in ECB was explained with the model. By considering this result, a further path model was suggested to understand the effect of SDT in the experiment (see Figure 2.5).

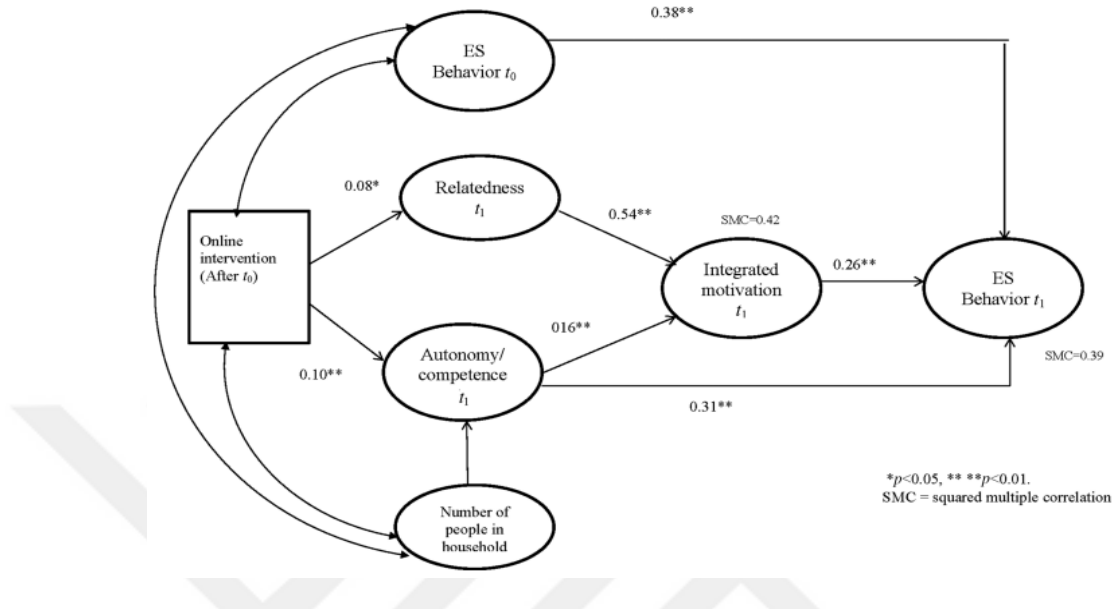


Figure 2.5 The path model proposed in Sweeney et al. (2014) and results obtained from that study

The improved model (Figure 2.5) fitted the data well ($\chi^2/df = 3.00$, CFI= 0.98, RMSEA = 0.05). The explained variation in ECB increased from 27% to 39%. The intervention had a small but significant effect on basic psychological types (for autonomy/competence: $\beta = 0.10$, $p < 0.01$; for relatedness: $\beta = 0.08$, $p < 0.05$). Furthermore, autonomy/competence and relatedness improved integrated motivation ($\beta = 0.16$, $p < 0.01$; $\beta = 0.54$, $p < 0.01$, respectively). Moreover, the relation between ECB and integrated motivation significantly positive ($\beta = 0.26$, $p < 0.01$). Besides, autonomy/competence need had also significantly positive relationship with ECB ($\beta = 0.31$, $p < 0.01$). The greatest relationship with ECB was found in previous behavior pattern ($\beta = 0.38$, $p < 0.01$).

2.6 Awareness of Energy-related Problems

One of the objectives highlighted in Tbilisi declaration is awareness of environmental problems. Awareness refers to “helping social groups and individuals acquire awareness and sensitivity to the total environment and its allied problems” (UNESCO/UNEP, 1978, p.15). This definition can be adopted energy-related problems which is a type of environmental problem. That is, awareness about energy-related problems represents the awareness of the link among energy-related problems and environment, society and economy. These are also the dimensions of sustainability. Therefore, pre-service science teachers’ (PSTs) awareness of energy-related problems is crucial in order to provide a sustainable view to students. To provide this view and satisfy the objectives determined in Tbilisi, inquiry based learning environment is stressed (Austin & Schmidt, 2010). EE is a wide field so that there are various ways to provide inquiry based learning environment. That is, many approach (e.g., place based education, action research and the science-technology and society approach) and teaching strategies supporting these approaches are exist (McDonald & Dominguez, 2010; Winther et al., 2010). Among these approaches and teaching strategies, there is not a common right. Regarding to the various parameters (e.g., topic, age of students, pre-knowledge of students, educational background of teacher and culture of school or society) the “best” pedagogic approach and teaching method show a variation (Winther et al., 2010). Among the instructional methods, by considering the nature of environmental problems and issues, field trips, argumentation and case studies are outstanding to exemplify in here. The study of Mastrilli (2005) also showed that these methods are commonly used in EE programs offered to PSTs, and the study of Yildirim (2015) indicated that pre-service science teachers mentioned these instructional strategies for teaching environmental problems and issues. In addition to teaching strategies for raising awareness, there are studies exploring the factors having relationship with awareness. Those studies are introduced below.

Previous published studies are limited to explain awareness of participants regarding energy related problems and issues. Among the limited studies, the study of Milstein (1977) focused on the awareness of people about energy-related problems through qualitative study. The study revealed that although the participants were aware that the demand for energy was greater than the supply, many of them were not aware of the dependence of US on foreign energy. Furthermore 30% of participants did not understand energy problems or they did not see any energy problem. The author emphasized the importance of the public's awareness of energy problems since he claimed that if people do not understand why they should conserve energy; they would not make an effort to conserve energy. Although the number of studies investigating awareness about energy related problems is restricted. There are several studies investigating the understanding of the relationship between energy use and global warming and climate change. For example, the study of Dal et al. (2015) investigated the relationship between awareness of climate change and climate change friendly behaviors with 603 pre-service teachers in Turkey. Three types of awareness were described within the study (i.e., awareness to impacts of climate change, awareness to climate change friendly individual initiative and awareness to industry initiative to address climate change.) A path model was proposed, which shows direct relationships between awareness types and behavior. The model showed a satisfactory fit to data (RMSEA: .50; SRMR: .00, CFI: 1.00) and 33% of the variance in pro-climate change friendly behavior was explained through the model. Another example studying awareness and climate change belongs to the study of Arslan, Cigdemoglu and Geban (2010). The study was conducted with preservice teachers in Turkey. The study showed that global warming and climate change was perceived as the most important environmental problems by preservice teachers. However, the majority of the participants could not justify the relationship between energy use and global warming and climate change problem. Similarly, the study of Choi et al (2010) revealed several misconceptions about climate change among middle and high school students. The common misconceptions were that they neither differentiate between greenhouse effect and climate change nor global

warming and climate change and students think that pollution or ozone holes cause climate change

Some efforts were made in order to increase awareness of energy use of people. For example, Bang, Torstensson and Katzeff (2006) developed a computer game in order to increase awareness of domestic energy consumption among teens before improving the game, the researchers examined the knowledge of 100 teenagers about how much electricity was used by various activities (e.g., using the computer for 2 hours, taking a bath for 30 minutes). According to the results, although the majority thought that energy conservation is important, their knowledge about how much electricity was used by the activities in home was quite low. The researchers claimed that in order to increase awareness of energy consumption, the consumers' knowledge about the amount of energy being used by the activities at home should be improved. A computer game was designed for this purpose. The paper discussed the pros and cons of game and suggested further studies which will investigate the change in participants' ECB. Similarly, Gamberini et al. (2011) developed a mobile game application, which provided feedback about the energy consumption. Besides, the application adopted tips, quizzes and a community area, which provided information about energy saving, rewards and achievements to the participants. The researchers tested this application with 24 participants who were playing the game over three months. The results revealed that participants found the application was helpful to increase awareness of energy conservation. Although these representative studies focused on the awareness of energy conservation, energy problems related to environment, society and economy were not salient.

Differently from the experimental studies for raising awareness about energy conservation, several studies were conducted to investigate the factors influencing awareness. For example, the study of Nordlund and Garvill (2003) investigated the factors influencing the willingness to reduce personal car use. Among the variables, general problem awareness and specific problem awareness were included to predict willingness to reduce car use. General problem awareness was defined as perceived environmental threat to biosphere and humankind. Specific problem

awareness refers to car traffic as cause if environmental problem and degree if seriousness of car-induced problems. The study was conducted with 1467 participants who lived in Sweden. The authors proposed a hierarchical model for the study. According to the model, general values and environmental values influenced general problem awareness; general problem awareness influenced specific problem awareness; specific problem awareness influenced personal norm (referring to perceived moral obligation to reduce personal car use) and personal norm influenced willingness to reduce personal car use. The results revealed that the goodness of fit indexes indicated a reasonable fit (RMSEA: .075, GFI: .98, AGFI: .94). The model explained 19% of variance in willingness to reduce personal car use. The results showed that awareness of the problem played an important role in the model for explaining the behavior of reducing car use.

Although the number of studies investigating awareness of energy problems is very limited, there are many studies examining environmental behaviors. Some of these studies are introduced above. Based on the results of these studies, it was assumed that awareness of energy issues is crucial for energy conservation behavior (ECB).

Awareness is also emphasized in self-determined motivation theory (SDT) as a fundamental element, which can assist basic psychological needs (Ryan & Deci, 2017). Much attention is concentrated on social-contextual factors (e.g., feedback, rewards, communication) in SDT such that these factors can foster or impede internalization of a behavior (Ryan & Deci, 2000b). Besides social-contextual factor, people have an innate capacity which aims realizing their own self-determination and satisfying psychological needs. That is, even though the social-contextual conditions inhibit internalization of behavior, awareness can support the self-regulation process (Ryan & Deci, 2017). Although SDT points the importance of awareness in internalization process of behavior, empirical data supporting this argument is lack in environmental education literature to understand pro-environmental behavior. However, there are some studies stressing the relationship between motivation and pro-environmental behavior. For instance, the study of Karaarslan et al. (2013) designed and SDT based environmental education course.

Results revealed that throughout the course PSTs' awareness of personal role and environmental actions were improved, which indicated that their basic psychological needs throughout the course were supported. Those PSTs who were aware of personal role and environmental actions started to question the extent and frequency of their environmental behavior and started to feel more confident about environmental behaviors throughout the course. In addition, they felt more self-determinedly motivated toward environment.

As Ryan and Deci indicated, basic psychological needs can be supported through awareness. The study of Karaarslan et al. (2013) provided evidence that raising awareness of PSTs about environmental issues make them be willing to take action and feel more confident about taking actions. Moreover, increase in their awareness inspired them to raise this awareness in their community. In this way, the participants stated that they could address the problem. These results showed that raising awareness supported PSTs' autonomy, competence and relatedness needs. Similarly, Abrahamse et al. (2007) emphasized the important role of raising and increasing awareness of energy-related problems in order to improve households' energy conservation.

CHAPTER 3

METHOD

The present chapter explains the method that was used throughout the study. The chapter starts with the design of the study explaining what kind of research methodology was employed. Afterwards, population and sample of the study was introduced. Then, the data collection instruments, data collection procedure and data analysis procedure were explained. Followed by this, validity and reliability issues of instruments were clarified. Finally, external validity of study and threats to internal validity were introduced.

3.1 Research Design

The current study is based on mixed method research design which includes both quantitative and qualitative research in which researchers collect both quantitative and qualitative data and analyze them (Fraenkel, Wallen, & Hyun, 2012). Creswell and Plano Clark (2011) defined 4 types of mixed method research which are triangulation, embedded, exploratory and explanatory designs. Among these types of mixed method designs, explanatory type of design was appropriate to use in this study. In explanatory type of design, researcher collects quantitative data and requires collecting qualitative data to elaborate results. In this type of design, the researcher collects quantitative data firstly. Followed by this, qualitative data is collected to flesh out the quantitative results. Two types of data are analyzed separately and the researcher presents qualitative data to elaborate the results of quantitative study (Fraenkel, et al., 2012).

In the light of this method, to understand how attitudes toward energy conservation, basic psychological needs for energy conservation and motivation toward energy conservation related to ECB of PSTs quantitative data were collected. As a second step, to expand upon the results attained from quantitative data, PSTs' perceptions on energy problems and solutions, their understanding on the relation between energy and climate change and their hopes and fears for future of energy were investigated to elaborate their attitudes and motivations for conserving energy. The interviews were conducted with PSTs from three different universities which are located in Ankara. The research design of the study was summarized in Figure 3.1.

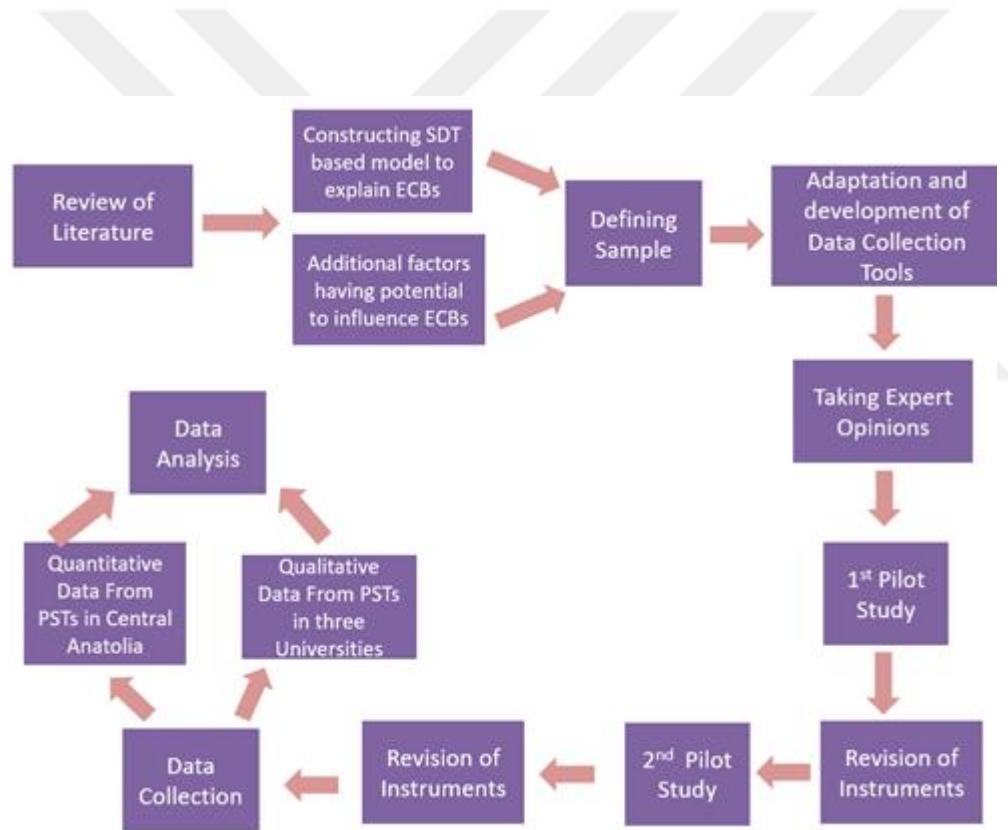


Figure 3.1 Overview of the study

As shown in Figure 3.1, the study started with the review of the literature. The variables affecting ECB were examined in this step. Then, the guided model presented in introduction chapter was constructed. In order to elaborate the results attained from quantitative data, qualitative part of the study was planned. Interviews

with PSTs were conducted in three universities. After that, population and sample were defined. This step was followed by the adaptation of instruments. Then, expert opinions were gathered for the instruments. Next, the pilot study was conducted and some revisions for the instruments were done. Finally, the instruments were ready to collect the data for the main study.

Elementary Science Education (ESE) Program is a 4-year program which educates science teachers for grade 4 to 8 in the schools of the Ministry of National Education. PSTs are required to complete coursework, suggested by the Council of Higher Education. All must courses are common for all universities. The program of Council of Higher Education shows the content knowledge for each must course. According to this program, Environmental Science course may include energy related topic with energy resources, energy related problems and issues and energy conservation. Environmental Science course is a three credit course with three hours for each week. Most of the universities offer this course at 3rd grade level but a few of them offer this course at 4th grade. The topics covered in this course regarding Council of Higher Education were showed in Table 3.1

Table 3.1
Topics covered in Environmental Science Course

Environmental Science Course
Historical development of Environmental Science
Human and Environment, population and environment, regional and local environmental problems: Water, Soil, Air and Radioactive Pollution and other resources pollution.
Biodiversity and status of it in Turkey: Flora and Fauna
Endemic plants and animals in Turkey.
Endangered species
Organization related to environment and their activities, environmental education and sustainable development

The topics being showed in Table 3.1 cover variety of issues related to environmental science. The objectives for the course, teaching strategies and the

course materials are determined by the university lecturers. As a specific topic, kinds of energy related problems, teaching strategies and teaching material may show differences among universities. In addition to the must courses, universities offer selected courses to undergraduate students. According to the program of science education, PSTs take three selected courses. The universities have flexibility for offering elective courses. Therefore, universities show differences in the elective courses they offer.

3.2 Population and Sample

The population of the quantitative phase of the study was the pre-service science teachers (PSTs) in 3th and 4rd grades from the universities located in Central Anatolia region. The sample is totally 1136 PSTs from 11 universities which are selected by convenient sampling method. The population of junior and senior PSTs in Anatolian region is 2252. The population was estimated regarding the quota determined by the Council of Higher Education for each year. Table 3.2 shows population of PSTs in each university. Overall, the number of the participants in the sample is approximately half of the population (50.44%).

The sampling method of the qualitative phase of the study was purposive sampling. The participants were selected according to the following criteria:

- (1) The number of participants in Ankara was the highest in the quantitative phase of the study. Therefore, participants were selected from three Universities in Ankara and these Universities were labeled as University A, University B and University C to protect the participants' personal rights.
- (2) The quantitative phase of the study involved junior and senior PSTs. Therefore, the qualitative phase involved junior and senior PSTs.
- (3) Participants, who were highly volunteered to participate were selected.

Table 3.2
Population and sample of the study

University Name	3 rd Grade		4 th Grade		Total	
	Population	Sample	Population	Sample	Population	Sample
Ahi Evran University	88	65	160	63	248	128
Aksaray University	52	27	45	23	97	50
Cumhuriyet University	108	63	200	106	308	169
Erciyes University	72	30	130	86	202	116
Gazi University	98	86	180	64	278	150
Hacettepe University	108	30	100	28	208	58
Kirikkale University	77	42	140	75	217	117
Necmettin Erbakan University	88	73	160	75	248	148
Nigde University	57	35	100	30	157	65
Middle East Technical Univ.	62	32	55	29	117	61
Osmangazi Univ.	62	36	110	38	172	74
TOTAL	872	519	1380	616	2252	1136

Overall, 26 PSTs participated in the qualitative phase of the study (see Table 3.3). The participants of University A and University C were reached by the help of research assistants in these universities. The research assistants of junior and senior

grade levels asked volunteer PSTs in their courses. The names of volunteers were collected with their contact information, and the interviews were conducted with highly volunteered. The participants of university B were reached by their e-mail address. An e-mail which addressed the aim of the study and asking for volunteer participation for the study, was sent. Then, PSTs who returned to the mail were selected.

Table 3.3
Number of participants enrolled in qualitative phase of the study

University Label	Number of junior PSTs	Number of senior PSTs
University A	5	5
University B	4	4
University C	4	4
TOTAL	13	13

For this study PSTs in University A were offered various elective courses in the scope of art, music, sports, social sciences and natural sciences. Among these subject areas, related to EE and ESD, education faculty offers education and awareness for sustainability, climate change education for sustainability and laboratory applications in environmental education courses to undergraduate students. These courses are planned in the frame of EE or ESD approach regarding the syllabuses. The PSTs at University A participated in qualitative part of the study, took at least one of these elective courses besides Environmental Science course.

University B also offers various elective courses. Syllabuses of these courses were put on the university websites. The courses that may include environment are; environment, recycling and waste economy, introduction to sustainability, conservation biology, creative recycling and reuse projects, ecology and

environment, energy saving and efficiency. However, when the syllabuses of these courses were examined, differently from University A, these courses were not planned in the frame of EE or ESD approach. The PSTs at University B in the qualitative part of the study took environmental science course and they did not take any other course related to environmental education.

The elective courses of University C are shown in their website as well. Differently from University A and University B, University C offers restricted courses. Similarly to the participants of University B, The PSTs in University C did not take any course related to EE except for Environmental Science.

3.3 Data Collection Procedure

Before the data collection, ethical permission was taken from METU ethical committee. The pilot of the study was enrolled during the fall term of 2014-2015. The main study was conducted in the spring term in 2015. The quantitative data was collected during the course hours. The permission of lecturers was taken and the instruments were conducted during the course hours. 30 minutes were given PSTs to complete the questionnaire. The data was collected from the volunteers. The qualitative data was collected from PSTs between May 2015 and October 2015. The interviews with PSTs were conducted in either a classroom environment or in a seminar room. The interviews lasted one hour averagely. The shortest interview was carried out fifteen minutes, and the longest interview was hold two hours.

In addition to interviews, syllabuses were used as a data collection instrument. The syllabuses of courses, which were highlighted in the interviews with PSTs, were used as data resource for the present study. Information related to the subjects, objectives and teaching methods were explored in order to triangulate the information attained from interviews regarding the courses.

3.4 Data Analysis Procedure

Two types of data, quantitative and qualitative types, attained from the study. Quantitative data was analyzed in two main sections. The first section included descriptive statistical analysis and checking the assumptions of path analysis which were conducted through IBM SPSS Statistics 23. Descriptive analyses were carried out for describing the characteristics of sample such as demographic information and the mean of responses given to the items. The main statistics used for this purpose were means, mode and standard deviations. The second section included inferential statistics that CFA and path analysis, special types of SEM, were used. CFA and path analyses were conducted via Analysis of Moment Structures (AMOS) 18 software.

CFA was used to examine the hypothesized factor structures of instruments and the validity of instruments. In this sense, the purpose of CFA is to recognize latent factors accounting for the variation and covariation among the observed indicators. CFA requires a theoretical hypothesis identifying the factorial structure (Brown, 2006). In order to assess the factor structure of the instrument, “goodness of fit indices” attained from the output of CFA are examined. A variety of model fit indices were reported to assess the “goodness of fit” of the hypothesized model. Brown (2006) identifies three categories of fit indices that are absolute fit indices, parsimony correction indices and comparative fit indices. Absolute fit indices is interested in if the predicted variance- covariance matrix is equal to sample’s variance- covariance matrix. Commonly used absolute fit indices are Chi-square (χ^2), RMR and SRMR values (Harrington, 2009). Chi-square tests if the model fits exactly to the population. However, there are some problems with using χ^2 . One of the problem is that there is not an upper threshold for this index. Another problems is related to sample size that χ^2 is sensitive to sample size. χ^2 index is very large with large sample size. To overcome this problem, some researchers divide χ^2 to its degrees of freedom (Kline, 2011). Although there is not a clear cut off point for χ^2/df , Sumer (2000) suggested to take 5 as a cut point. On the other hand, Kline

(2011) suggested taking cut off point as 3. The suggestion of Sumer (2000) was taken into consideration in this study. Root Mean Square Residual (RMR) index refers to the average discrepancy between the covariances in the input matrix and the covariances predicted by the model. Standardized Root Mean Square Residual (SRMR) index is the standardized form of RMR that is easier to evaluate. For that reason, researchers prefer using SRMR over RMR.

Parsimony correction indices are the second category. The root mean square error of approximation (RMSEA) is the most commonly used index in this category. This index tests the extent to which the model fits reasonably well in the population (Harrington, 2009). RMSEA was suggested to use with its 90% confidence interval (Kline, 2011).

The last category is comparative fit indices which evaluate the fit of a model relative to a more restricted, nested baseline model. CFI and TLI are most commonly used indexes for this category (Harrington, 2009).

Kline (2011) suggested to use model chi-square (χ^2), normed chi square (χ^2/df), CFI, SRMR, RMSEA and 90% confidence interval for RMSEA to assess the model fit. The suggestion of Kline (2011) was taken into consideration and these indices were used to evaluate the factor structure of instruments and the results of path analysis. Table 3.4 summarizes the model fit indices that used for the study and the values indicating good fit.

Maximum likelihood (ML) estimation method was used in CFA. ML is one of the estimation methods used in SEM and it is the most used method (Kline, 2011). ML estimation is simultaneous that estimation of all parameters is done at once. Further, the estimations are assumed to maximize the likelihood that the data were drawn from its population (Kline, 2011). There are three fundamental key assumptions for the use of ML. First is related to sample size. The sample size should be large. The second is that the indicators should be measured on continuous scales. The third assumption is that the distribution of the latent variables should be normally distributed (Brown, 2006). CFA was applied to continuous scales in this study. The

normality assumption for all latent variables was satisfied and the sample size of the main study was large enough to satisfy the assumption. Shortly, all assumptions of ML were satisfied for the study.

Table 3.4

Model fit indexes used for the current study

Model Fit Index	Values for Good Fit
Chi-square (χ^2)	small
χ^2/df	< 5
CFI	$\geq .90$
SRMR	< .10
RMSEA	< .10
90% CI for RMSEA	narrow

Path analysis enables researcher to develop or test a theoretical model with a systematic methodology (Kline, 2011). This study used path analysis to test the direct influence of attitudes toward energy conservation, psychological needs for energy conservation and motivation toward energy conservation to eco-management and persuasion type of energy conservation behaviors.

This research also included the collection of qualitative data through interviews conducted with PSTs. The interviews were firstly transcribed for the analysis phase. A private firm was arranged to transcribe the audio basis data to word document. The transcripts were checked by the researcher before starting the analysis. The analysis of interviews was performed through coding process. The coding process was performed by using of a software program (Maxqda 12). Maxqda 12 helps researcher to organize data and to enables researcher to code the data in a more systematic way.

A code is generally a word or a short phrase assigning symbolically. It represents the primary content and essence of a datum (Saldana, 2009). Coding provides

researcher to organize data and to make interpretation about the data. In other words, coding help researcher cluster similar segments and make possible drawing conclusions from the data (Miles, Huberman & Saldana, 2014). Miles et al. (2014) listed sixteen types of coding (e.g., descriptive coding, in vivo coding, process coding, emotion coding). Among these types of coding, descriptive coding is used for this current research. “A descriptive code assigns labels to data to summarize in a word or short phrase— most often a noun— the basic topic of a passage of qualitative data” (Miles et al., 2014, pg. Kindle Locations 2344). The codes emerged from this study describe PSTs’ schemas in their mind about energy related problems & solutions, their understanding in the relation between energy and climate change, their hopes and fears for the future of energy and their ECB. Therefore, it was thought that among the coding types described by Miles at al. (2014), descriptive coding is the most appropriate coding type.

The initial open coding process was done by the researcher that the responses of PSTs were coded question by question. While coding the texts, the reports of Intergovernmental Panel on Climate Change (IPCC), the books for environmental and nature resource economics (e.g., Harris & Roach, 2013; Tietenberg & Lewis, 2012) and the books for sustainable development and education for sustainability (e.g., Corcoran & Wals, 2004; Fien & Tilbury, 1996; James, 2015) were read to find out the labels. The descriptions of codes were defined based on the international reports and the literature emerged from environmental and nature resource economics. Then, the codes were revised by the researcher and similar codes were merged. Followed by this, the emerged codes were revised and they were discussed with two professors whose major area was environmental education and science education. These discussions with the professors were made in different times. Based on the discussions, some of the codes were clustered and labelled again. After the modifications of the codes, the categories were constructed.

3.5 Internal Validity and Reliability Issues of Instruments

English versions of instruments were translated and adapted to Turkish by the researcher. Then, the translation was controlled by an instructor from the Department of Modern Languages. Followed by this, face validity and content validity of instruments used in quantitative phase of study were provided by two experts who are currently working as science education professors. The experts were asked for suggestions about below issues:

1. To evaluate whether the items (both added and translated) adapted to Turkey context appropriately.
2. The meaning of items may miss during the translations. Therefore, we are expecting from experts to evaluate whether the items translated into Turkish appropriately
3. To evaluate if the items meet the meaning of sub-dimensions of instruments.

According to the feedback of experts, some items were either excluded from the test or improved. Furthermore, before conducting the pilot study, two PSTs were asked to check readability, clarity, and fluency of items as well as the understanding of content as being test takers. According to all these feedbacks, the items were revised and the pilot study was conducted. The final revisions were made regarding the results of pilot data. Further information for each individual instrument is provided below sections.

3.5.1 Exploratory Factor Analysis (EFA) and Confirmatory Factor Analysis (CFA)

Field (2009) explained the aim of factor analysis under three titles. First is to understand the structure of latent variables, second is to construct a questionnaire and the last one is to reduce the data set for a manageable size. EFA was used in this study to explore the structure of latent variable. Among the various type of

method in EFA, principle axis factoring was selected and as a rotation solution, direct oblimin which is a type of oblique rotation was used since the factors are thought to be correlated with each other.

Confirmatory factor analysis (CFA) was also used to test validity of instruments. Harrington (2009) summarized the aim in the use of CFA as:

Within social work, CFA can be used for multiple purposes, including—but not limited to—the development of new measures, evaluation of the psychometric properties of new and existing measures, and examination of method effects. CFA can also be used to examine construct validation and whether a measure is invariant or unchanging across groups, populations, or time. (pg.5)

As Harrington (2009) suggested, CFA is used in this study to discover the construct validation of the instruments. In order to evaluate whether the hypothesized construct is valid or not, a variety of model fit indices were used. While the CFA is evaluated, chi-square (χ^2), CFI, SRMR, RMSEA and 90% confidence interval for RMSEA were used as suggested by Kline (2011).

Kline (2011) summarized two main differences between EFA and CFA in his book. One is that EFA does not require a priori hypothesis about the number of factors. Every item in a test/scale can load to each item. Researchers can make inferences about high loadings and theorized the output of EFA analysis. The point in here is that EFA does not require a hypothesis to apply it on factors. The other difference Kline emphasized is that EFA does not have a single parameter for factor models. It uses a variety of rotation solutions to interpret factor structure of a scale. On the other hand, CFA does not require rotation factor models to be estimated because the factors have already been theorized beforehand. Setting covariance among factors is permitted in CFA but this type of specification is usually not essential in EFA.

While deciding on the use either EFA or CFA, the criteria of Kline (2011) is considered. If the researcher had the prior hypothesis about the structure of the

instrument CFA was used. To illustrate, attitude toward energy saving instrument developed by Abrahamse and Steg (2009) is one dimensional with four items that the researcher has a factor model for the instrument. If the hypothesized factor model does not work, EFA was conducted to explore the factor structure of the instrument.

3.5.1.1 Demographics instrument

Demographics questionnaire is a self-developed scale that presents information about gender, university, hometown, presence of power plant and mine in hometown, mother education level, father education level and residence (See Appendix A).

3.5.1.2 Attitudes toward Energy Conservation Instrument

Abrahamse and Steg (2009) defined attitude in their study as “a degree to which a person has a favorable or unfavorable evaluation of a behavior.” The authors developed attitude toward energy conservation (ATEC) instrument based on this perspective. This instrument is a 5- point Likert scale (1-strongly disagree, 2-disagree, 3- neither agree nor disagree, 4- agree, 5- strongly agree) having four items with unidimensional factor structure. The instrument’s Cronbach’s alpha (α) value was found as .74 by the study of Abrahamse and Steg (2009). The items in the instrument are reverse items and they all are recoded that a higher score reflects a positive attitude toward energy conservation.

This instrument was translated into Turkish by the researcher. The translation was controlled by Department of Modern Languages in METU and by two experts who are currently working as professors in Science Education Department. Once the items were approved by the experts, the pilot study was planned. The pilot study was conducted to 172 PSTs. The instrument is one dimensional that the researcher

has a hypothesis for one structure. Therefore, confirmatory factor analysis (CFA) was conducted to approve the unidimensional structure of the instrument. Before conducting CFA, the assumptions of it were checked. Namely; sample size, normality and linearity, outliers, absence of multicollinearity and singularity, and residual were checked. Sample size is suggested as at least 200 (Kline, 2011). The sample size of the pilot study was 172 which was close to the reference point. This sample size is suggested to be increased regarding the complexity of the model (Kline, 2011). Rather than testing a complex SEM model, CFA was conducted. Therefore, it was thought that this sample size was enough. Missing value for each item was between 0% and 2.9%. The missing value lower than 5% is not a problematic issue (Tabachnick & Fidel, 2013). Missing values were replaced with mean in the pilot study. Any violation of the rest of the assumptions was not detected for the pilot study. Then, CFA was conducted with maximum likelihood estimation method. The fit indices obtained from CFA are shown in Table 3.5.

Table 3.5

Goodness-of-fit indices of ATEC instrument with regard to pilot study

Instrument Name	χ^2	df	χ^2/df	CFI	SRMR	RMSEA	90% CI for RMSEA
ATEC	10.246	2	5.123	.94	.05	.15	.07 - .26

The goodness-of-fit index supports that the instrument is one dimensional. Although RMSEA value is greater than .10, SRMR value is below .10. RMSEA tends to improve as the number of variables increased (Kenny & McCoach, 2003). The number of observed variables is quite low in attitude factor. This may be the reason for the high index of RMSEA. As the rest of the indices are quite well, it can be concluded that the attitude instrument has one dimensional with good-fit-indices.

The reliability (α) of ATEC instrument was measured as .70 in the pilot study. Further, item total correlation score was found to be greater than .30 for each item (Field, 2009).

The main study was performed with four items and CFA was conducted to support the factor structure of the instrument in the main study. Before conducting CFA, assumptions of CFA including normality and linearity; outliers; absence of multicollinearity and singularity; and residuals were checked. The percentage of missing data was lower than 5% that mode imputation method was used by considering the grade and university to deal with missing data. Sample size is big enough to satisfy the assumption. Then, assumptions for normality and linearity; outliers; absence of multicollinearity and singularity; and independence of residuals were checked. All assumptions were satisfied for CFA. As the assumption check was completed, CFA was conducted. Goodness of fit indices were shown in Table 3.6

Table 3.6

Goodness-of-fit indices of ATEC instrument with regard to main study

Instrument Name	χ^2	df	χ^2/df	CFI	SRMR	RMSEA	90% CI for RMSEA
ATEC	23.101	2	11.550	.97	.03	.09	.06-.13

The goodness of fit indices of ATEC showed good model fit that supported the construct validity and its unidimensional factor structure. AMOS output of measurement model for ATEC instrument is provided in Appendix C. The reliability (α) of the instrument was found as .70 in the main study. Furthermore, inter-item correlation values of all items were between .41 and .54. All these evidences supported that the instrument satisfied the validity and reliability issues.

3.5.1.3 Energy Conservation Behavior Instrument

Energy conservation behavior (ECB) instrument is a 5-point Likert scale (1- never, 2- rarely, 3-sometimes, 4- frequently, 5- always) that includes the items from the energy literacy instrument of DeWaters (2011) and Sahin (2013). The construct of behavior instrument of DeWaters (2011) is organized as three dimensional that are individual energy consumption behaviors (with 6 items; eg., I turn off the computer when it is not being used), family purchase of energy saving equipment (with 2 items; e.g., my family buys energy efficient compact fluorescent light bulbs) and family adjustment of household temperature to save energy (with 2 items; e.g., I am willing to encourage my family to turn the heat down at night or the air conditioner up when we are not home to save energy). In this current study, family purchase and family adjustment of household items were adapted to my family/room-mates/dormitory management since some PSTs still live with their family, some of them stay at dormitory or share a house with room-mates. Table 3.7 shows the original form and adapted form of items. Although the construct of behavior instrument of DeWaters (2011) was created as three dimensional, the instrument was treated as unidimensional in the further analysis. The construct of behavior instrument of Sahin (2013) is unidimensional. The Cronbach's alpha (α) value of ECB instrument of DeWaters (2011) is .81 and the Cronbach's alpha value of (α) the instrument of Sahin (2013) is .72. In conclusion, the items in these two instruments and an additional item added by the researcher (item 8 in the 1st pilot study) were included in the first pilot study (see Table 3.7). As a result of first pilot study, revisions were made and new items were added for the second pilot study.

Table 3.7

Items used in the 1st pilot study

Items in Turkish	Items in English	The original form of item
1. Suyu tasarruflu kullanırım	I save water.	I try to save water.
2. Kısa mesafelerde arabaya binmek yerine yürümeyi ya da bisiklete binmeyi tercih ederim.	I prefer walking or biking to go short distances, instead of riding a car.	I walk or bike to go short distances, instead of riding a car.
3. Odadan çıktığımda ışıkları kapatırım.	When I leave a room, I turn off the lights.	When I leave a room, I turn off the lights.
4. Bilgisayarı kullanmadığımda kapatırım.	I turn off the computer when it is not being used.	I turn off the computer when it is not being used.
5. Günlük kararlarımın çoğu enerji kullanımı ile ilgili düşüncelerimden etkilenir.	Many of my everyday decisions are affected by my thoughts on energy use.	Many of my everyday decisions are affected by my thoughts on energy use.
6. Enerji tasarrufu yapmak için geceleri kombinin/kaloriferin ısınısını düşürürüm.	I turn the heat down at night to save energy.	I turn the heat down at night to save energy.
7. Enerji tasarrufu yapmak için ailem/ev arkadaşlarım/yurt yönetimini geceleri kombinin/kaloriferin ısınısını düşür.	My family/my roommates/dormitory management turns the heat down at night to save energy.	My family turns the heat down at night or the air conditioner temperature up when we are not home to save energy.
8. Enerji verimliliği yüksek ev aletleri almayı tercih ederim.	I prefer buying energy efficient home appliances.	

Note. * reverse items

Table 3.7 (continued)

Items in Turkish	Items in English	The original form of item
9. Enerji tasarrufu yapmaları için ailemi/ ev arkadaşlarımı/yurt yönetimini geceleri için/kaloriferin ısınısını düşürmeleri için teşvik ederim.	I encourage my family to turn the heat down at night to save energy.	I am willing to encourage my family to turn the heat down at night or the air conditioner up when we are not home to save energy.
10. Enerji tasarruflu kompakt floresan ampuller alırım.	I buy energy efficient compact fluorescent light bulbs.	My family buys energy efficient compact fluorescent light bulbs.
11. Enerji tasarruflu kompakt floresan ampuller almaları konusunda ailemi/ev arkadaşlarımı/ yurt yönetimini teşvik ederim.	I encourage my family/ my roommates/ dormitory management to buy energy efficient compact fluorescent light bulbs	I am willing to encourage my family to buy energy efficient compact fluorescent light bulbs.
12. Enerji tasarrufu yapmak için daha az şey almaya razıyım.	I am willing to buy fewer things in order to save energy.	I am willing to buy fewer things in order to save energy.
*13. Ellerimi ve yüzümü yıkamadan önce suyun ısınması için suyu bir süre boşa akıtırım.	I let the water run until it gets hot before I wash my face and hands.	I let the water run until it gets hot before I wash my face and hands.
14. Enerji tasarrufu için ailemi/ ev arkadaşlarımı/yurt yönetimini damlayan sıcak su musluğunu tamir etmeleri konusunda teşvik ederim.	I would encourage my family/ my roommates/ dormitory management to fix a dripping hot water faucet to save energy.	I would encourage my family to fix a dripping hot water faucet to save energy.
15. Çamaşır ve bulaşık makinesini çalıştırmak için tamamen dolmasını beklerim	I wait until I have a full load before doing my laundry.	I wait until I have a full load before doing my laundry.

Table 3.7 (continued)

Items in Turkish	Items in English	The original form of item
16. Banyo yaparken suyu tasarruflu kullanmak için sabunlanırken musluğu kapatırım.	While I am taking a bath, I turn off the facet while cleaning my body with soap to save water	
17. İşim bittiğinde elektrikli aletlerin fişini çekerim.	I unplug electric machines when I finish my work	
*18. Kış aylarında içeriye temiz hava girmesi için odamın pencerilerini uzun süre açık bırakırım.	In the winter, I leave the windows open for long periods of time to let in fresh air.	In the winter, I leave the windows open for long periods of time to let in fresh air.
*19. Kış aylarında kalın giyinmektense ilave ısıtıcı çalıştırırım.	In the winter, I keep the heat on so that I do not have to wear a sweater.	In the winter, I keep the heat on so that I do not have to wear a sweater
*20. Yaz aylarında pencereyi açmak yerine klima ya da vantilatör çalıştırırım.	In summer, I make use of the air-conditioned and/ or the fan.	In summer, I make use of the air-conditioned and/ or the fan
21. TV, Play Station, müzik seti gibi aletleri kumandanın yanı sıra düğmesinden de kapatırım.		
22. Çamaşır makinesini düşük sıcaklıkta ve ön yıkamasız çalıştırırım.	I run the washing machine at low temperature and without pre-washing	I wash dirty clothes without prewashing.

The first pilot study of ECB was conducted to 320 PSTs from 2 different universities on Mediterranean region in Turkey. To examine the construct validity of scale, EFA was conducted by principle axis factoring method with Direct oblimin rotation. In order to decide the number of factor revealed from the EFA, scree plot criteria was selected (Green& Salkind, 2004). The boundary value of the factor score was set as .30 which is the minimum factor loading score. Before conducting EFA, all assumptions, namely sample size, factorability of the correlation matrix, linearity, and outliers among cases, were checked (Pallant, 2007). The sample size is suggested to be 150 at least that this assumption was satisfied. Factorability of the correlation matrix assumption was checked with Barlett's test of Sphericity and Kaiser-Meyer-Olkin value. Barlett's test of Sphericity was found as significant ($p<.05$) and the value of Kaiser-Meyer-Olkin was found as .80. The rest of the assumptions were also satisfied for EFA. Scree plot was examined to find out the number of factor. According to the scree plot, the instrument is unidimensional and explained 22% of variance in ECB. Then, the items were tested for reliability through SPSS. The Cronbach alpha value with 22 items was found as .79. However, when item-total correlation values were examined, it was found out that this value for items 8,13,16,18,19,20,21 and 22 was lower than .30. It means that these items were measuring something different from the scale as a whole (Pallant, 2007). Regarding the results attained from the first pilot analysis, these items in the behavior instrument were either deleted or revised regarding the environmental behavior framework of Hungerford et al. (1994). The framework of Hungerford et al. (1994) categorized environmental behaviors under five categories which were eco-management, consumer action or economic action, persuasion, political action and legal action. According to this framework, many of the items in ECB instrument can be categorized as either eco-management or persuasion behavior. Eco-management behaviors refer to individual actions that people directly do to prevent or solve environmental issues. In terms of ECB, eco-management behaviors are people's individual actions that directly decrease their energy consumption (e.g., When I leave

a room, I turn off lights). Persuasion refers to people's effort to make their friends/family or a society convince on saving energy to prevent or solve environmental issues (e.g., I encourage my family/roommates/dormitory management to turn the heat down at night to save energy). When this framework and definitions were thought, there were some items that were not fit in these categories. These items are numbered as 2, 5, 7 and 12. Item 2 (I prefer walking or biking to go short distances, instead of riding a car) is a preference which does not reflect an actual behavior. For that reason, this item does not fit any behavior category of Hungerford et al. (1994) and it is excluded from the instrument. Item 5 (Many of my everyday decisions are affected by my thoughts on energy use) refers to a decision making process and it is not directly related to an individual behavior. Therefore, this item was excluded. Item 7 (My family/my roommates/ dormitory management turns the heat down at night to save energy) is not a personal behavior rather it is the behavior of others that is not appropriate to put it in the instrument. Therefore, this item was also excluded for the second pilot study. Item 12 (I am willing to buy fewer things in order to save energy) is a willingness item that does not fit any behavior category of Hungerford et al. (1994) hence it was excluded from the instrument. Lastly, item 8 (I prefer buying energy efficient home appliances) refers to preference that it is excluded from the study. Items which did not fit the behavior category of Hungerford et al. (1994) and items having low item loadings were omitted from the instruments. Shortly, these omitted items were 2, 5, 7, 8, 12, 13, 18 and 19. Items numbered 16 and 22 were decided to revise for second pilot study. Furthermore, new items were added for the second pilot study. These items were shown in Table 3.8

As a result, ECB instrument includes 14 items for the second pilot study and these items are related to household energy conservation. Second pilot study was conducted with 172 PSTs from 2 different universities on Mediterian region in Turkey. These 2 universities are different from the universities used in the first pilot study.

Table 3.8

New items added to the instrument for second pilot study

Items in Turkish	Items in English
Ailemi enerji verimliliği yüksek ev aletleri almaları konusunda teşvik ederim.	I encourage my family to buy energy efficient home appliances.
Dişlerimi fırçalarken suyu kullanmadığım sırada musluğu kapatırım.	If I do not use water, while brushing my teeth I turn off the tap
Gereksiz yere takılı olan fişleri prizden çekirim.	I unplug nonuse home appliances

For the second pilot analysis, it was hypothesized that items 1, 3, 5, 8, 9, 10, 11, 12 and 14 were in the category of eco-management related energy conservation behavior. Items 2, 4, 6, 7 and 13 were hypothesized in the category of persuasion related energy conservation behaviors (see Appendix D).

As we have a prior hypothesis, CFA was used to see how items worked with the hypothesized factors. Before conducting CFA, all assumptions were checked. Although the sample size is recommended as 200 at least (Kline, 2011), the sample size was 172. However, Kline (2011) recommended to considering the complexity of model while deciding on the sample size. Rather than testing a complex SEM model, CFA was conducted to the pilot study. Therefore, it was thought that 172 participants were thought to be proper. Missing value for each item was between 0% and 1.2%. The missing value was lower than 5% that any method for handling it recommended (Tabachnick & Fidel, 2013). Mean imputation method was used to handle with missing values for the pilot test. Any violation of the rest of the assumptions was not detected for the pilot study. Then, CFA was conducted with two factorial structure. The results showed that standardized estimate value of Item 12 (I stay at shower for a short time to save energy (less than 10 minutes) was .30 which is on the limit. When item 12 was removed from CFA, the fit indices of model were improved. Therefore it was decided to remove this item from the instrument and CFA was repeated. In order to overcome

unfit indices, AMOS 18 offers modification indices that should be considered. Modification results revealed that two error covariance should be set. One of them is between item 5 (I unplug nonuse home appliances) and item 10 (I unplug electric machines when I finish my work). The error covariance should be between item 5 and item 3 (I turn the unnecessary lights off). These two modifications are reasonable since the items are under the same factor and these items are related to energy conservation related to home appliances. Therefore, these two error covariance were set to improve the good-fit-indices of model for ECB instrument. After doing these adjustments, the goodness of fit indices shown in Table 3.9 were revealed.

Table 3.9

Goodness-of-fit indices of the model for ECB revealed in the second Pilot

Instrument Name	χ^2	df	χ^2/df	CFI	SRMR	RMSEA	90% CI for RMSEA
ECB	142.072	62	2.291	.91	.06	.09	.06-.10

As shown in Table 3.9, the results revealed acceptable fit indices and supported two factorial structure of ECB.

In addition to CFA for validity, reliability coefficient of ECB was examined. Cronbach's alpha reliability coefficient (α) of eco-management was found to be .85 and reliability (α) of persuasion was found to be .80. Further, item total correlation score was found to be greater than .30 for each item (Field, 2009). To summarize, the pilot tests suggested that the behavior instrument has two dimensions which were eco-management behaviors and persuasion behaviors.

The main study was conducted with 13 ECB items (see Appendix E). CFA was conducted to the ECB instrument with two dimensions which are eco-management and

persuasion behavior. Before conducting CFA, assumptions for the test were checked. Missing data analysis was conducted. The percentage of missing data for each item was lower than 5%, so mean imputation method was used to deal with missing data. The sample size was big enough to conduct the analysis. Afterwards, assumptions for normality and linearity; outliers; absence of multicollinearity and singularity; and independence of residuals were tested. Skewness and kurtosis values of each item were between +2 and -2 that provided evidences for normality. Normal QQ plots also showed that majority of observations were close to the line and they were linear. Further, Bivariate correlations between the items were examined for absence of multicollinearity and singularity. Covariation among the item errors was not allowed in CFA. Then, CFA was run. AMOS output of measurement model is attached in Appendix F. The results were summarized in Table 3.10.

Table 3.10

Goodness-of-fit indices of the model for ECB in the main study

Instrument Name	χ^2	df	χ^2/df	CFI	SRMR	RMSEA	90% CI for RMSEA
ECB	495.106	64	7.736.	.89	.05	.08	.08-.09

Several fit indices were considered while interpreting the results of CFA. Although normed chi-square (χ^2/df) value is higher than 5, CFI, RMSEA and SRMR values indicated reasonably good fit indices. It can be concluded that behavior instrument with two factors structure fit the data well. The correlation between eco-management and persuasion behavior was found to be .62 in the output of AMOS. It means that the discriminant validity was provided that two factors measuring different constructs (Kline, 2011).

For reliability, the Cronbach alphas (α) was examined. This α was found as .80 for eco-management and it was .73 for persuasion behavior. The inter item correlation values for each item was higher than .30 that indicates all item belongs to their own factor.

Ultimately, model fit indices of ECB showed good fit between the model and the study data. It was confirmed that eco-management and persuasion behaviors can be used to assess PSTs' energy conservation behavior. The Cronbach alphas (α) values for eco-management and persuasion behaviors indicated that the Turkish version of ECB is reliable.

In conclusion, ECB was measured with two dimensions which were eco-management behavior and persuasion behavior. CFA and Cronbach alpha value supported that the ECB is valid and reliable instrument to measure PSTs' energy conservation behavior.

3.5.1.4 Factor Structure of Basic Psychological Needs for Energy Conservation Instrument

Basic psychological needs comprises of three dimensions which are autonomous, competence and relatedness (Deci & Ryan, 1985). Sweeney et al. (2014) developed basic psychological needs for energy conservation (BPNEC) based on the study of Deci & Ryan (1985). This instrument is a 7-point Likert scale (1- strongly disagree, 7- strongly agree) and includes 9 items. The instrument was developed by considering the three dimensions (autonomy, competence and relatedness) of basic psychological needs. However, the study of Sweeney et al. (2014) showed that the instrument is two dimensional which are autonomy/competence and relatedness. The Cronbach's alpha (α) value of sub dimensions of instrument are .88 and .94 respectively.

4 items were added (items numbered as 1, 3, 5 and 7) to this instrument for two main reasons. One was to increase the number of items for each sub dimensions in order to increase reliability. The other reason was to make the instrument appropriate to Turkish culture (see Appendix G). The sub dimensions are autonomy (Items 1, 2, 5, 9, 12), competence (items 3, 6, 8, 10) and relatedness (items 4, 7, 11, 13). An expert whose major research is based on motivational theories in science education was consulted to take suggestions about the added items and the adaptation of items to Turkish. Then, the pilot study was conducted. Before running CFA, the assumptions of it were checked. Namely; sample size, normality and linearity, outliers, absence of multicollinearity and singularity, and residual were checked. Sample size is suggested as at least 200 (Kline, 2011). The sample size of the pilot study was 172 which was close to the reference point. This sample size is suggested to be increased regarding the complexity of the model (Kline, 2011). Rather than testing a complex SEM model, CFA was conducted. Therefore, it was thought that this sample size was enough. Missing value for each item was between 0% and 3.5%. The missing value lower than 5% is not as a problematic issue that any method for missing data can be used (Tabachnick & Fidel, 2013). Missing values were replaced with mean in the pilot study. Any violation of the rest of the assumptions was not detected for the pilot study. Then, CFA was conducted with maximum likelihood estimation. CFA was performed with three factor structure (autonomous, competency and relatedness). However, the correlation between autonomous and competency factors was 1.00, which means these two factors do not measure distinct factors and violating discriminant validity (Kline, 2011). As a result, three factor structure of basic psychological needs was not satisfied. Therefore, EFA was conducted to examine the factor structure. Two basic issues considered before conducting EFA. One is the sample size and the other is the strength of the relationship among items (Pallant, 2007). Sample size is suggested as 5:1 ratio that 5 participants for each items (Tabachnick and Fidel, 2007). This assumption was satisfied that BPNEC included 13 items in the pilot study and the sample size was 172. In addition to this, sample size assumption is tested with the Kaiser-Meyer-Olkin

(KMO) measure through SPSS. KMO index ranges from 0 to 1. The minimum value with .6 is suggested for KMO index (Tabachnick and Fidel, 2007). Additionally, Bartlett's test of sphericity provides evidences for the appropriateness of data for factor analysis. The test result should be significant ($p < .05$). EFA analysis showed that KMO value was .90 and Bartlett's test of sphericity was found to be significant ($p < .05$). The assumptions for EFA were satisfied. Followed by this, EFA was conducted with principles axis factoring method and direct oblimin rotation was used. While deciding on the number factors, Kaiser criteria suggested by Kaiser (1974) and scree plot criteria suggested by Pallant (2007) were considered. The analysis showed that BPNEC instrument has two dimensional constructs (see Table 3.11).

Table 3.11

Initial Eigenvalues of the Factors of BPNEC

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	6.555	50.420	50.420
2	1.198	9.215	59.634

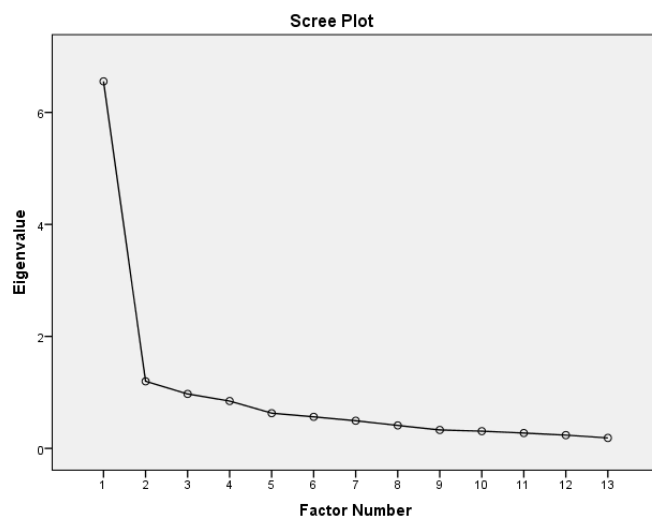


Figure 3.2 Scree plot of BPNEC

EFA on BPNEC produced two factors with eigenvalues higher than 1.0. Scree plot also supported that the instrument is two dimensional. Two dimensional construct explained the 59% of variance with regard to eigenvalues. Factor loadings and communalities of each item was presented in Table 3.12. Items having factor loadings lower than .30 was suggested to be dropped (Pallant, 2007; Stevens, 2002). Item 5 having low factor loading (.17) and low communality that this item was decided to be dropped. Therefore, this item was not included in

Table 3.12

Items and Rotated Factor Loadings of BPNEC

Factor Loadings			
Items	Factor 1	Factor 2	Communality
BP1	.767		.598
BP2	.783		.613
BP3	.742		.551
BP4		-.741	.554
BP6	.813		.696
BP7		-.741	.557
BP8	.686		.539
BP9	.705		.517
BP10	.611	-.624	.457
BP11		-.894	.799
BP12	.519	-.518	.322
BP13		-.817	.677

Items 10 and 12 have almost equal loadings on two factors. Theoretically these items belong to Factor 1 and they were placed to factor 1 for further analysis. It was found out that items which belong to autonomous and competence factors loaded to factor one, and items which belong to relatedness loaded on factor 2. This result is parallel with the study of Sweeney et al. (2014) who adjusted psychological needs to energy conservation. Merging these two factors is supported theoretically that Ryan and Deci (2000) claimed competence develops intrinsic motivation when competence complemented by sense of autonomy. Then, Factor 2 was labeled as as relatedness.

Followed by this, CFA was run and Table 3.13 shows the goodness of fit indices of BPNEC instrument with two factorial structure depend on the data obtained from the pilot study.

Table 3.13

Goodness-of-fit indices of the model for BPNEC in the pilot study

Instrument Name	χ^2	df	χ^2/df	CFI	SRMR	RMSEA	90% CI for RMSEA
BPNEC	151.864	53	2.865	.92	.06	.10	.09 - .12

Covariation among the item errors was not allowed in CFA. The results shown in Table 3.13 showed that the model reasonably fit the data and supported two factorial structure of BPNEC instrument. The reliability of this instrument was measured with Cronbach alpha (α) value. The reliability of autonomy/competence dimension was found as .89 and the inter-item correlation value of items was between .52 and .78. The reliability of relatedness was found as .88 and the inter-item correlation value of items was between .69 and .79.

Regarding the results obtained from pilot study, one item was excluded and the main study was conducted with twelve items (see Appendix H). CFA was performed with two factorial structure. Covariation among the item errors was not allowed. AMOS output of measurement model is available in Appendix I. Table 3.14 shows the results of CFA.

Table 3. 14

Goodness-of-fit indices of the model for BPNEC in the main study

Instrument Name	χ^2	df	χ^2/df	CFI	SRMR	RMSEA	90% CI for RMSEA
BPNEC	364.723	53	6.882	.94	.04	.07	.06 - .08

Several fit indices were considered in order to decide if the proposed model fit the data. Although χ^2/df value is 6.9 which is out of there reference point, CFI, SRMR and

RMSEA indices provided evidence for reasonably good fit indices. It can be concluded that the model fit the hypothesized factor structure. Further, the latent factor correlation between two factors was found as .72 that shows the discriminant validity was met. Next, the reliability of the sub-dimensions was examined with Cronbach alpha value (α). It was found as .86 for autonomy/competence and the inter-item correlation value of items was between .46 and .67. The α value was found as .82 for relatedness factor and the inter-item correlation value of items was between .58 and .72. In conclusion, the results supported that BPNEC is a valid and reliable instrument with two factorial structure to measure PSTs' psychological needs for energy conservation.

3.5.1.5 Factor Structure of Motivation toward Energy Conservation Instrument

Motivation toward Environment Scale (MTES) was developed by Pelletier et al. (1998) and it is adapted to Turkish by Karaarslan (2011). This scale is a 7-point Likert scale (1- strongly disagree, 7-strongly agree) and including 21 items. MTES has six sub dimensions that are intrinsic, integrated, identified, introjected, external and amotivation. The Cronbach's alpha (α) value of sub dimensions of Turkish version of MTES ranged from .70 to .90. This instrument was modified to energy conservation by the researcher and this version is labelled as motivation toward energy conservation (MTEC). MTEC included 32 items (see Appendix J). 11 items (items 3, 5, 6, 9, 15, 16, 20, 22, 28, 29 and 32) were added by the researcher in order to modify the instrument to the energy conservation context. The definition of the dimensions and the features of SDT were thought while adding the new items to the instrument. Then, the items were shown to an expert whose major research is based on motivational theories in science education and the suggestions of this expert were taken. The expert found the items were proper to the description of dimensions. Followed by taking the approval of the expert, the pilot study was conducted.

The pilot study was applied to 172 PSTs. In order to confirm the theoretical six factor structure of MTEC, CFA was conducted. Before conducting CFA, all assumptions which are sample size, normality and linearity, outliers, absence of multicollinearity and singularity, and residual were checked. Kline (2011) suggested that the sample size should be 200 at least and this sample size should be increased with regard to the complexity of the model. Rather than testing a complex model, CFA was used for the pilot study to understand if the instruments work. For that reason, the sample size for the pilot study was thought to be sufficient. Missing value for each item was less than 5% that any method for missing can be used (Tabachnick & Fidel, 2013). Mean imputation was used for missing values in the pilot study. The normality assumption was checked with skewness and kurtosis values that George and Mallery (2003) identified skewness and kurtosis values acceptable at ± 2 range. The normality assumption was satisfied that the skewness and kurtosis values were between -.55 and .50. The histogram diagrams for all sub-dimensions were also checked and they all satisfied the normality assumption. The rest of the assumptions were satisfied for the pilot study. Then, CFA was conducted with six dimensions, namely intrinsic, integrated, identified, introjected, external and amotivation. Maximum likelihood estimation method was used for CFA. Covariation among the item errors was not allowed.

CFA showed that following items' factor loading values were lower than .30. These items were: item 9 ($\beta=.15$), item 20 ($\beta=.04$), item 21 ($\beta=.26$) and item28 ($\beta=.26$). Further, factor loading (β) of item 23 was found as negative ($\beta=-.32$). These findings showed that items 9, 20, 21, 23 and 28 were not working properly. These items were deleted and CFA was run again. The fit indices obtained from the analysis was shown in Table 3.15

Table 3.15

Goodness-of-fit indices of the model for MTEC in the pilot study

Instrument Name	χ^2	df	χ^2/df	CFI	SRMR	RMSEA	90% CI for RMSEA
MTEC	584.171	309	1.894	.91	.06	.07	.06 - .08

The fit indices showed that the hypothesized six factor model fit the data. All observed variables were significantly loaded in their factors. Discriminant validity is also examined to decide the number of factor. To do this, the latent factor correlations were examined. It was claimed that if the latent factor correlation is higher than .85, the factors do not measure distinct constructs rather they merged and measure the same construct (Brown, 2006; Henseler, Ringle & Sarstedt, 2015). Kline (2011) takes this reference point as .90 that the correlation higher than .90 indicates the violation of discriminant validation. The reference of Brown (2006) and Henseler et al. (2015) was considered in this study. Table 3.16 shows the latent factor correlations obtained from CFA.

Table 3.16

Correlation among the sub-dimensions of MTEC revealed in the pilot study

	Intrinsic	Integrated	Identified	Introjected	External	Amotivation
Intrinsic	1	.79	.96	.87	-.41	-.70
Integrated		1	.85	.84	-.30	-.45
Identified			1	.85	-.49	-.72
Introjected				1	-.31	-.60
External					1	.80

When the Table 3.16 was examined, it was found that latent factor correlation between intrinsic and identified, intrinsic and introjected, integrated and introjected, identified and introjected types of motivations were highly correlated that they violated discriminant validity. Therefore, it can be concluded that intrinsic, integrated, identified and introjected types of motivation were clustered and composed one dimension. The relation between external and amotivation dimensions was less than .85 that they were distinct constructs. As a result, 6 factor structure of MTEC was not supported and EFA should be conducted to explore the factor structure of MTEC. However, the number of factors is large in MTEC instrument and the sample size of pilot study was not large enough to examine the factor structure. Therefore, it was thought to test the factor structure with the main data since the sample size was large enough to examine factors. As a result of pilot study, it was found that four items (Items 9, 20, 21, 23 and 28) were not worked properly. For that reason, these items were excluded from the instruments and main study was conducted with 27 items (Appendix K).

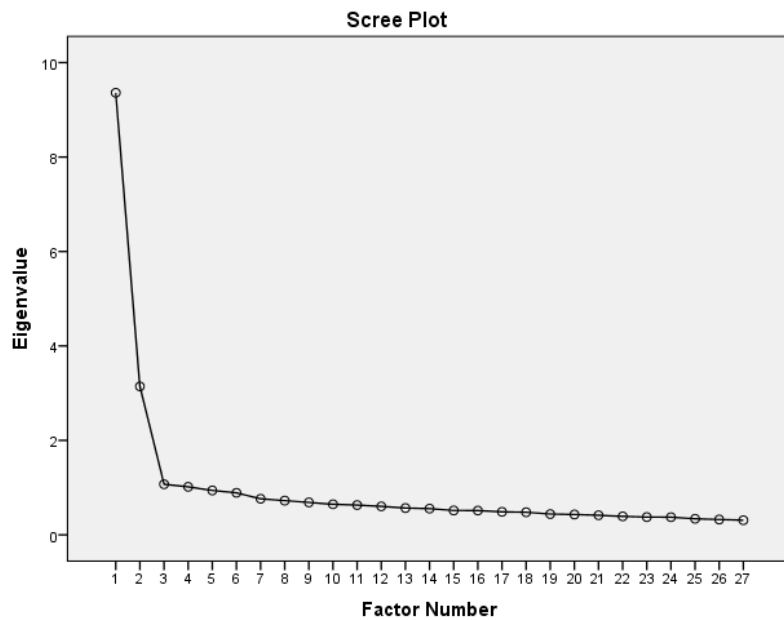
Six factorial structure of motivation toward energy conservation instrument cannot be provided with pilot data. For that reason, EFA was conducted to main data to explore the factors.

EFA analysis showed that KMO value was .95 and Bartlett's test of sphericity was found to be significant ($p < .05$). These results showed that the assumptions for EFA were satisfied. Followed by this, EFA was conducted with principles axis factoring method and direct oblimin rotation. While deciding on the number factors, Kaiser criteria suggested by Kaiser (1974) and scree plot criteria suggested by Pallant (2007) were considered. The analysis showed that MTEC instrument has four factors (see Table 3.17).

Table 3.17

Initial Eigenvalues of the Factors of MTEC

Component	Initial Eigenvalues		
	Total	% of Variance	Cumulative %
1	9.362	34.673	34.673
2	3.144	11.645	46.318
3	1.072	3.972	50.290
4	1.016	3.765	54.054

*Figure 3.3 Scree plot of MTEC factors*

EFA on MTEC produced four factors with eigenvalues higher than 1.0 (see Table 3.18). However, scree plot did not support the four factorial structural (see Figure 3.3). According to Field (2009), Kaiser Criteria would be more reliable than scree plot, when sample size is larger than 250. Therefore, Kaiser Criteria is taken into consideration and four factors are accepted and tested with CFA later. Four factorial structure

explained the 54% of variance with regard to eigenvalues. Factor loadings and communalities of each item was presented in Table 3.18. Items having factor loadings lower than .30 was suggested to be dropped (Pallant, 2007; Stevens, 2002). All factor loadings were higher than .30.

Table 3.18

Items and Rotated Factor Loadings of MTEC

Factor Loadings					
Items	Factor 1	Factor 2	Factor 3	Factor 4	Communality
M9	.764				.590
M7	.746				.560
M20	.727				.531
M12	.724				.528
M18	.707				.524
M23	.701				.497
M5	.659				.445
M19	.657				.483
M17	.648				.427
M25	.637				.447
M26	.631				.440
M14	.602				.387
M1	.501				.271
M2	.435		.453		.248
M16		.744			.556
M11		.739			.551
M22		.718			.531
M8		.605		.432	.398
M3		.562			.323
M21		.561		.450	.379
M13			.776		.609
M10			.751		.568
M15			.738		.568
M4			.584		.397
M27				.708	.502
M6				.582	.366
M24				.564	.408

When the factors were examined it was observed that items in intrinsic, integrated and identified factors collapsed together and composed one factor. Item M2 is expected to load on factor 1 since it is an item from integrated motivation. However, this item also

loaded on Factor 3. This item's factor loading on Factor 1 and Factor 2 were almost equal. The rest of the items in integrated motivation loaded on Factor 1. Therefore, this item was decided to be taken in Factor 1. This factor is labelled as self-determined motivation based on the study of Standage, Duda and Ntoumanis (2003) that these three motivation types collapsed and the authors labelled the new dimension as self-determined motivation. For this reason, Factor 1 is labelled as self-determined motivation. Six items were loaded on Factor 2. 4 out of 6 items were external motivation items and two items were amotivation items. These two items were also loaded on Factor 4. The items in Factor 4 are amotivation items. Therefore, items 8 and 21 were taken to Factor 4. In this way, Factor 2 was labelled as external motivation. Items in Factor 3 were introjected types of items that Factor 3 was labelled as introjected motivation. Lastly, items in Factor 4 were amotivation items that this factor was labelled as amotivation. To sum up, MTEC instrument with 27 items was tested on EFA. The results revealed four factor solution that Factor 1 was labelled as self-determined motivation, Factor 2 was labelled as external motivation, Factor 3 was labelled as introjected motivation and Factor 4 was labelled as amotivation. This finding was parallel with the study of Standage et al. (2003) and the labels they used were considered in this study.

Followed by EFA, CFA was conducted with 4 factors structure. Before conducting CFA, all assumptions were checked for the main study. Sample size of the main study was 1136 that the sample size assumption was met. The normality assumption was checked with skewness and kurtosis values and histogram diagrams. George and Mallery (2003) identified skewness and kurtosis values acceptable at ± 2 range. The skewness and kurtosis values were between -.86 and .99 that provided evidences for satisfaction of normality assumption. Histogram diagrams for all sub-dimensions were also supported the satisfaction of normality assumption. The rest of the assumptions were also fulfilled for the main study. Followed by checking the assumptions, CFA was conducted with four factors. AMOS output of measurement model for MTEC is

provided in Appendix L. Covariation among the item errors was not allowed in this analysis. The results of CFA was summarized in Table 3.19

Table 3.19

Goodness-of-fit indices of the model for MTEC in the main study

Instrument Name	χ^2	df	χ^2/df	CFI	SRMR	RMSEA	90% CI for RMSEA
MTEC	1320.697	318	4.153	.93	.05	.05	.05-.06

Several fit indices were considered while evaluating the model fit. χ^2/df , CFI, SRMR and RMSEA values showed that four factor structure hypothesized model fit the data well. All observed variables were significantly loaded in their factors. Besides, the standardized estimates of factor loadings ranged from .53 to .79. Followed by this, latent factor correlations were examined to control the discriminant validity of factors. All correlations among the factors were found less than .85 (see Table 3.20). It means that all factors measure distinct constructs. The reliability of factors was measured through Cronbach alpha value. Cronbach alpha (α) value of self-determined, introjected, external types of motivation and amotivation was found as .92, .82, .79 and .74 respectively.

Table 3.20

Correlation among the sub-dimensions of MTEC revealed in the main study

	Self-determined	Introjected	External	Amotivation
Self-determined	1	.81	-.36	-.56
Introjected		1	-.19	-.36
External			1	.82

To sum up, the validity and reliability issue of MTEC instrument was provided with four factorial structure, namely self-determined motivation, introjected motivation, external motivation and amotivation. This finding is parallel with the study of Standage et al. (2003) that it is also supported theoretically.

3.5.1.6 Interview protocol

Semi structured interviews were conducted with PSTs from three different universities. Berg (2001) described semi-structured interview as:

This type of interview involves the implementation of a number of predetermined questions and/or special topics. These questions are typically asked of each interviewee in a systematic and consistent order, but the interviewers are allowed freedom to digress; that is, the interviewers are permitted (in fact expected) to probe far beyond the answers to their prepared and standardized questions. (p.70)

The standardized interview protocol was created to elaborate the results attained from quantitative part of the study. The interview questions asked to PSTs were related to their PSTs' perceptions about energy problems and solutions, their understanding the relation between climate change and energy and their hopes and fears for future of energy, and their motivation for ECB. These questions shed in light to their attitudes toward ECB, their awareness and understating of energy problems and issues.

Some of the questions in the interview protocol were modified from the study of Gwekwerere (2015). Gwekwerere created the questions for environmental problems and issues. These questions were modified to energy related problems and solutions, hopes and fears for the future of energy. The rest of the questions were prepared by the researcher. While the questions were modified and new questions were create, the themes shown in Table 3.21 were considered. Before conducting the interviews, expert

opinions were taken. These experts consist of two professors in environmental education, one professor in science education and one professor in renewable energy engineering. Regarding their suggestions, the interview protocol was improved (see Appendix M).

Table 3.21

Themes and Interview Questions

Themes	Interview Questions
Awareness about energy-related problems (including perceived problems and solutions)	• What do you think about the energy problems waiting for solution in Turkey? • What do you think about the energy problems waiting for solution in the world? • Do you think it is difficult to solve these problems, why/why not? • What are your hopes and concerns for the future of energy use? • What are your hopes and concerns for the future of energy production? • What are your hopes and concerns for the future of energy saving?
Understanding of climate change	• Do you think there is a relationship between climate change and energy issue? If yes, how? • Do you think there is a relationship between climate change and energy conservation? If yes, how?
The content of courses at college regarding energy issues	• Which courses did you take in university courses included energy related problems and issues? • What topics and concepts are taught in these courses related to energy in the university? • Which energy-related problems are involved in these courses? • What is involved regarding the use / consumption and production of the energy in these courses? • What is involved regarding the energy conservation in these courses • Is the relationship between sustainability and energy issues involved? If yes, how?

Table 3.21 (continued)

Themes	Interview Questions
The content of courses at college regarding energy issues	• Is the relationship between energy conservation and sustainability involved? If yes, how? • Is the relationship between energy use/production and climate change examined in these courses? If yes, how? • Is the relationship between energy conservation and climate change examined in these courses? If yes, how?
Instructional features of courses perceived by PSTs	• What kinds of teaching methods were used while the instructor(s) included energy-related problems and issues? • What kinds of teaching environments were used while the instructor(s) included energy-related problems and issues? • What kinds of teaching materials were used by the instructor(s)? (e.g., books, case studies, films)

3.5.1.6.1 Trustworthiness of Interview Analysis

To provide the trustworthiness of study, inter coder agreement method was used (Creswell 2007). Miles and Huberman (1994) suggested to do check-coding to make clear the meaning of codes and to provide the reliability of coding. The authors recommended more than one person to code 5-10 pages of the transcribed document and calculate the reliability based on the following formula:

Reliability= number of agreements / total number of agreements + disagreements

Miles and Huberman (1994) indicated that at first, one may not get 70% agreement on the codes. However, they claimed that the inter-coder reliability value should be close to 90% eventually. In order to provide the inter-coder reliability, a colleague whose major study is based on science education coded one of the participant's interview and 85% agreement was provided.

3.6 External Validity

Fraenkel et al. (2012) described external validity as the extent to the generalization of results. The sample of quantitative data was composed almost half of the population. Therefore, the results attained from the quantitative data were generalized to Central Anatolian region.

In terms of qualitative research, generalizability is a limitation since the number of sample is generally very low when compared with quantitative analysis (Creswell, 2012). Merriam (1994) argued that:

While some qualitative researchers view generalizability as a limitation of method, or just not appropriate for the social sciences, most prefer to think of generalizability as something different than going from a sample to a population. The goal of qualitative research, after all, is to understand the particular in depth, rather than finding out what is generally true of many. (p. 57).

Merriam clearly points out that the crucial point in qualitative research is to understand a particular thing in a detailed way. The qualitative part of this study did not aim to make a generalization instead it aimed to understand how PSTs perceive energy related problems & solutions, the relation between energy and climate change, their hopes and fears for the future of energy and if these variables have an influence on their energy conservation behavior. To summarize, the generalization was aimed in the quantitative part of the study since almost half of the population was reached. However, a generalization was not an issue in the qualitative part of the study regarding the nature of qualitative study.

3.7 Threats to Internal Validity

Fraenkel et al.(2012) described internal validity as:

When a study has internal validity, it means that any relationship observed between two or more variables should be unambiguous as to what it means rather than being due to “something else. (p.166).

The “something else” is referred to threats to internal validity. These threats are listed as subject characteristics, mortality, location, instrumentation, testing, history, maturation, attitude of subjects, regression and implementation (Fraenkel et al., 2012). Each threat is discussed below by considering the design and data collection procedure of this present study.

3.7.1 Subject characteristics

A subject characteristic refers to the selection of participants that is different from one another in unintended way in which affect the results obtained from the study. Subjects are asked to provide demographic characteristics such as gender and grade level in this study to present them in the description of the sample. These variables may have an influence on ECB. However, the researcher restricted her exogenous (independent) variables to the theoretical constructs shown in the guided model to test. In other words, this study was delimited to the theoretical constructs (e.g., attitudes toward energy conservation, basic psychological needs, motivation toward energy conservation) that the rest of the variables (e.g., the socioeconomic level, gender) were not the focus issue in the study.

3.7.2 Mortality

Mortality threat is the loss of participants due to withdrawal or the low rate of involvement of participants to the study may affect the outcome of the study. This threat was eliminated by collecting data during the course hours to ensure the return of surveys.

3.7.3 Location

The location in which the data were collected may influence the results. This threat was controlled by collecting survey instruments at class. The interviews were also conducted in silent places either in a class or in a conference room.

3.7.4 Instrumentation

Instrumentation threat involves instrument decay, data collector characteristics and data collector bias. Instrument decay is a problem when scoring instruments is changing in some way or another. It especially happens when the rater is fatigue. The instrument included affective variables that the researcher did not score any item. The instruments were applied as an optical form by a private firm and the firm entered the data to excel sheets and SPSS. Each optical form had an identity that participants' answers can be checked. They were checked by the researcher. Shortly, the data entered in an electronic environment and they were controlled. Therefore, it is believed that participants' responses entered correctly and instrument decay was controlled. Another threat in instrumentation is data collector characteristics. This threat is controlled by standardization of collection of data by one researcher. All quantitative data except for one university was collected by the same researcher. The quantitative data obtained from this University was collected by a colleague of researcher who is working in this

university. The colleague was informed about the nature of study and the same procedure for collecting data was followed. All qualitative data was collected by the researcher. In this way, the collection of data procedure was standardized. The last threat in instrumentation is data collector bias. The characteristics such as age, gender, ethnicity of data collector may influence the results. It is believed that the current study was not influenced by these types of characteristics due to the nature of study topic.

3.7.5 Testing

Testing is the concern of experimental studies since it is related to the administration of the instrument multiple times. The instruments and the interviews were administered one time in this study. Therefore, this threat is not an issue for this study.

3.7.6 History

History threat includes the unanticipated or unplanned occasions happening during the data collection period that influence the results of the study. During the data collection period it is believed that this kind of threat was not included in the study.

3.7.7 Maturation

If a change in any cognitive or physiological variable happened due to maturation rather than the implementation of a study, maturation thereat may appear in a study. This threat is mostly possible in experimental studies. The current study is based on one time data collection. In this manner, the probability of appearance of this threat is considered to be unlike.

3.7.8 Attitude of Subjects

The attitudes of participants toward the study can influence the study overall. For example, they may answer the questions in a way that they believe the researcher would prefer. This threat is also known as Hawthorne effect. In order to avoid from this threat, the participants were acknowledged that this is not an exam influencing their GPA. Further, they were asked to participate in the study voluntarily and be honest in their responses.

CHAPTER 4

RESULTS

This chapter is divided into four main sections. First section concerns the preliminary analysis, which includes data screening procedure. The second section is based on the descriptive statistics of the variables in the quantitative part of the study. The third section involves the assumptions of path analysis and the results of path analysis. The last section is devoted to the results of qualitative analysis.

4.1 Preliminary Analysis (Data Screening)

Before conducting the inferential analysis, screening data is essential in order to check the data for possible faults. To this end, missing data, outliers and normality were all checked through IBM SPSS Statistics 23.

Missing Data Analysis

Firstly, the researcher scanned the data and excluded three cases, which had many missing data. Then the missing percentage for each items was investigated. The missing percentage of the majority of the items was below 1%, and the missing value ranged from 0% to 2.1%. Tabachnick and Fidel (2011) suggested using any kind of imputation method when the percentage of missing data is lower than 5%. Mode imputation method was used by considering the universities and grades. To this end,

the mode values for each grade and each university were estimated and replacement was done separately for each university and grades.

Outliers

In order to identify univariate and multivariate outliers, a number of strategies are suggested. Among these strategies, use of Z-scores, Mahalanobis distance and Cook's distance were used in this present study. Detailed information about the identification of outliers is presented in the assumptions of inferential statistics.

Normality

In order to check the normality of the variables (i.e., attitudes toward energy conservation, dimensions of motivation toward energy conservation, basic psychological needs for energy conservation and energy conservation behavior), skewness and kurtosis values were examined. In addition to this, histograms of each variable were also investigated. George and Mallery (2003) identified skewness and kurtosis values acceptable at ± 2 range. The maximum value of skewness and kurtosis is 1.9 as shown in Table 4.1. It shows that the skewness and kurtosis values are between the acceptable values. The results of histograms also supported this finding.

4.2 Descriptive Analyses

4.2.1 Attitude toward Energy Conservation

In order to measure the participants' attitudes toward energy conservation, the instrument of Abrahamse and Steg (2009)'s was used. Respondents are asked to rate their agreement with the items on a five point-Likert scale (1-strongly disagree, 2-disagree, 3- neither agree nor disagree, 4-agree, 5- strongly agree). All items in this

instrument is reversed items and they all recoded that a higher score reflects a positive attitude toward energy conservation. Conversely, a low score indicates a negative attitude toward energy conservation.

Table 4.1

Univariate Normality Statistics

Variable	Skewness		Kurtosis	
	Statistic	Std. Error	Statistic	Std. Error
Attitudes toward energy conservation	-.71	.07	.42	.15
Autonomy/competence	-.18	.07	-.46	.15
Relatedness	-.46	.07	.02	.15
Self-determination	-.80	.07	.67	.15
Introjected	-.75	.07	.13	.15
External	.82	.07	-.11	.15
Amotivation	.97	.07	.38	.15
Eco-management	-1.1	.07	1.9	.15
Persuasion	1.9	.07	-.09	.15

In this sense, Table 4.2 shows the descriptive results of attitudes toward energy conservation scale ($M = 3.83$, $SD = .71$). The results show that preservice science teachers' (PSTs) attitude toward energy conservation is quite high. It means that PSTs favor energy conservation behavior.

Table 4.2

Descriptive Statistics for Attitudes toward Energy Conservation

Variable	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
Attitudes Toward Energy Conservation	3.83	.71	1	5

4.2.2 Basic Psychological Needs for Energy Conservation

Sweeney, Webb, Mazzarol and Soutar (2014) developed basic psychological needs for energy conservation (BPNEC) based on the study of Deci and Ryan (1985). This instrument is a 7-point Likert scale (1- strongly disagree, 7-strongly agree). The study of Sweeney et al. (2014) showed that the instrument is two-dimensional which are autonomy/competence and relatedness. Confirmatory factor analysis of this present study also supported that the instrument is two-dimensional.

Table 4.3

Descriptive Statistics for Basic Psychological Needs

Variables	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
Autonomy/Competence	5.21	0.94	2.25	7
Relatedness	5.00	1.18	1.00	7

As Table 4.3 shows, PSTs feel that they are capable of conserving energy, and they conserve energy willingly ($M= 5.21$, $SD= 0.94$). The mean score of relatedness dimension is also quite high ($M= 5.00$, $SD: 1.18$). It shows that PSTs feel that people in their society may discuss the ways to conserve energy and support each other to conserve more energy.

4.2.3 Motivation toward Energy Conservation

Motivation toward Environment Scale (MTES) was developed by Pelletier et al. (1998). The items in this instrument were modified by the researcher in order to refer mainly to energy conservation, and this version is labelled as motivation toward energy conservation (MTEC). The instrument is 7 point-Likert type. The exploratory and confirmatory factor analyses show that the instrument has four dimensions, namely self-determined motivation, introjected regulation, external regulation and amotivation. In this context, Table 4.4 shows the descriptive statistics of MTEC regarding the responses of preservice science teachers (PSTs).

Table 4.4

Descriptive Statistics for Motivation toward Energy Conservation

Variables	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
Self-determined	5.78	.87	2.14	7
Introjected	5.46	1.26	1	7
External	2.56	1.44	1	7
Amotivation	2.31	1.22	1	7

According to the results, most of the PSTs had self-determined motivation toward energy conservation. PSTs' with self-determined motivation internalized the behavior into the self. PSTs with introjected regulation did not integrated the behavior into their identity but they felt that they should behave in this way in order to avoid the feeling of guilt or anxiety. That is, the majority of PSTs had either self-determined motivation or introjected regulation. It means that they exhibited energy conservation behavior since they internalized the behavior or since they had tendency to avoid the feeling of shame.

4.2.4 Energy Conservation Behavior

Energy conservation behavior (ECB) instrument is a 5-point Likert scale (1- never, 2- rarely, 3-sometimes, 4- frequently, 5- always) and includes the items from the energy literacy instrument of DeWaters (2011) and Sahin (2013). The researcher also added a few items to the instrument as mentioned in method chapter. The exploratory and confirmatory factor analysis showed that the behavior instrument has two dimensions, namely eco-management and persuasion. The higher scores mean that the participants conserve more energy.

Table 4.5

Descriptive Statistics for Energy Conservation Behavior

Variables	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
Eco-management	4.26	.57	1	5
Persuasion	3.45	.77	1	5

As shown in Table 4.5 the mean score of eco-management ($M = 4.26$, $SD = .57$) was higher than the persuasion behavior ($M = 3.45$, $SD = .77$). It means that PSTs tended to be more comfortable with displaying eco-management behavior than exhibiting persuasion behavior regarding the categories of energy conservation.

4.3 Path Analysis

Path analysis, a special type of SEM, was used in this study to test a theoretical model based on the relationship among the variables being selected and ECB. By path analysis, the relationships among the variables are explored through standardized path

coefficients. Figure 4.1 illustrated the modified theoretical model to be tested. It is modified according to the results of CFA used to investigate the dimensions of instruments.

4.3.1 Assumptions of Path Analysis

4.3.1.1 Sample Size and Missing data

Path analysis requires large sample size since the parameters are sensitive to sample size. Kline (2011) suggests a minimum sample size as 200 cases. This study exceeds the minimum size to satisfy this assumption (N=1136). Maximum likelihood (ML) was used as an estimation method for path analysis. ML method does not work with missing data. Therefore, an appropriate method should be used for missing values (Brown, 2006). The percentage of missing value for each item was lower than 5%, which is consistent with what Tabachnick and Fidel (2011) suggest. It was thought that the outcome variable (ECB) might be influenced by universities and grades. Therefore, mode imputation method was used by considering the universities and grades. It means that the mode for each grade and each university was estimated and replacement was done separately for each university and grades.

4.3.1.2 Normality and Linearity

Normality and linearity assumptions are checked in the preliminary analysis sections (see Table 4.1). The normality assumption was controlled with skewness and kurtosis values with ± 2 acceptable range, which was identified as such by George and Mallery (2003). The analysis showed that there was not any violation of this assumption (see Table 4.1)

4.3.1.3 Outliers

Stevens (2009) suggested using z-scores to detect the univariate outliers. Z scores larger than 4 can be considered as outliers. All scores of factors were converted to z-scores and no case larger than 4 was detected. Followed by this, multivariate outliers were checked with Mahalanobis distance. Mahalanobis distance score for each case was calculated and they were compared with critical value. Since there were 7 exogenous variables, the critical value was 24.32 (Pallant, 2007). There were 16 cases exceeding the critical value. Tabachnick and Fidell (2013) stated that these outliers are reasonably expectable with large sample size. Another way to detect the multivariate outliers is Cook's distance. The Cook's distance values above 1 can be a potential problem (Pallant, 2007). There was not any case having Cook's distance value larger than 1. By considering this result, and considering that Mahalanobis distance do not have undue influence on the results of path analysis, all cases were kept for path analysis.

4.3.1.4 Absence of multicollinearity and Singularity

When the variables are highly correlated (above .90) multicollinearity and singularity problem arises. In order to check this assumption, bivariate correlations among the variables were investigated and the results are summarized in Table 4.6. The results showed that any correlation larger than .90 was not found. It means that absence of multicollinearity and singularity assumption was satisfied.

Table 4.6

Bivariate correlations among the variables

	1	2	3	4	5	6	7	8	9
Attitude	1	.17**	.15**	.28**	.20**	-.28**	-.32**	.28**	.17**
Autonomy/ competence		1	.61**	.60**	.46**	-.11**	-.25**	.38**	.41**
Relatedness			1	.62**	.57**	-.07*	-.21**	.37**	.41**
Self-determined				1	.72**	-.30	-.47	.51**	.38**
Introjected					1	-.26**	-.30**	.41**	.35**
External						1	.63**	-.26**	.02
Amotivation							1	-.29**	-.08*
Eco- management								1	.46
Persuasion									1

** significant correlation at .01 level (2-tailed)

*significant correlation at .05 level (2-tailed)

4.3.1.5 Independence of Errors

The residuals should be uncorrelated to satisfy this assumption. One of the ways is to check the Durbin-Watson coefficient value. Durbin-Watson values less than 1 and larger than 3 indicates a concern for the independence of errors (Field, 2009). The value was calculated as 1.89 in this study. Another way used to check the independence of errors is to examine the residual covariance matrix in the output of AMOS. The values in this table should be small and centered around zero, which was the case in this study.

4.3.2 Model Specification

After the check of assumptions, path model was specified by using AMOS statistical software package program. As a first step, covariance was added between the exogenous variables (Kline, 2011). The guided model, which was hypothesized before the data collection, was introduced in introduction chapter. After the data collection, the validity of instruments was performed and the factors of instruments were

determined. Followed by this, regarding the results of validation process, modifications for the model were applied (see Figure 4.1). In this path model, only the direct relations were examined, and the following paths were proposed in this model:

- Paths were proposed from attitudes toward energy conservation to eco-management type of energy conservation behavior and persuasion type of energy conservation behavior. Indeed, the paths between attitudes and types of energy conservation behavior (ECB) were hypothesized as positive based on the literature.
- Paths were proposed from perceived basic psychological needs for energy conservation (i.e., autonomy/ competence and relatedness) to eco-management type of energy conservation behavior and persuasion type of energy conservation behavior. In particular, the paths between basic psychological types and types of energy conservation behavior (ECB) were hypothesized as positive based on the literature.
- Paths were proposed from motivation toward energy conservation (i.e., self-regulated, introjected, external and amotivation) to eco-management type of energy conservation behavior and persuasion type of energy conservation behavior. Specifically, the path between the types of ECB and self-determined motivation and introjected regulation were hypothesized as positive. On the other hand, the path between the types of ECB and external regulation and amotivation were hypothesized as negative based on the literature.

In addition to the proposed paths, covariations were set among attitude, the sub-dimensions of motivation toward energy conservation scale and sub-dimensions of basic psychological needs respectively, since these factors are correlated as mentioned in introduction and literature chapter. Besides, a covariance was set between the residuals of persuasion and eco-management behaviors since these two behavioral types are sub-dimensions of ECB (see Figure 4.1). As have been tested in CFA, the

relation between these two types of behaviors was less than .85, which shows that two constructs are distinct.

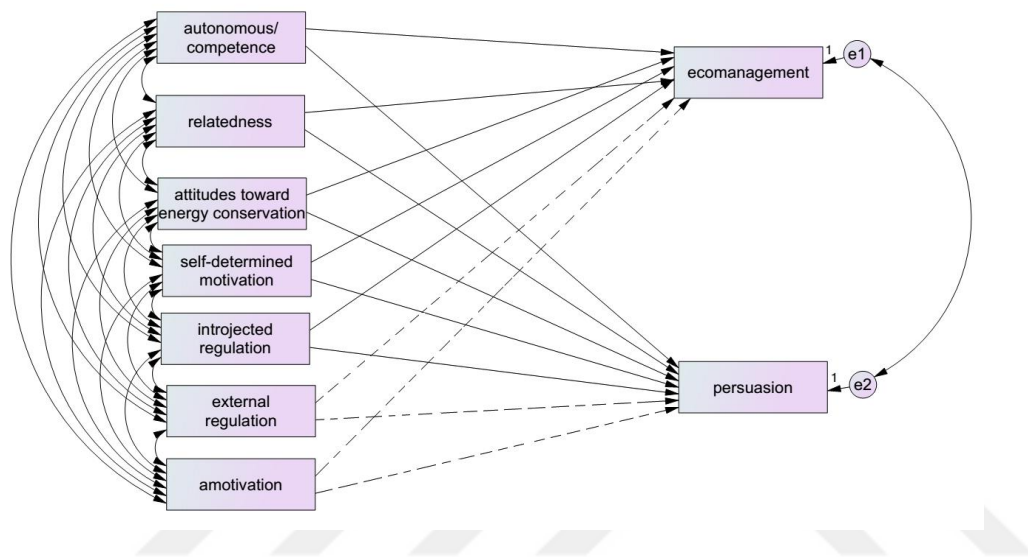


Figure 4.1 Improved path model to be tested

*the dashed lines represent the negative relationships.

4.3.2 Model Testing

The proposed model was tested through AMOS 18 software program. Followed by running the model, the estimations were examined to find out the meaningful paths. The results revealed that three paths were insignificant. These paths were from amotivation to eco-management ($\beta=.02$, $p>.05$), from amotivation to persuasion ($\beta=.05$, $p>.05$) and from relatedness to eco-management ($\beta=.05$, $p>.05$). These paths were deleted from the model and the model was run again. All paths were significant. Followed by this, the fit indices were examined. Among the several fit indices, chi square, normed chi square (χ^2/df), CFI, RMSEA and SRMR indices were considered to examine the model fit (Kline, 2011). The chi-square value was found as insignificant $\chi^2(1136) = 4.507$, $p=.212$. It means that the relations predicting the model were not

different from the sample. Besides, chi square (χ^2/df) is also examined since Chi-square can be sensitive to sample size (Kline, 1998). χ^2/df value was found as 1.502 indicating a reasonable fit according to Sumer (2000). CFI value was .99, which supported the model indicates a reasonable good fit. Consistently, RMSEA and SRMR values supported the good fit indices (RMSEA= .021; SRMR: .006; 90% CI for RMSEA: .00, .058). To sum up, the obtained fit indices consistently showed that hypothesized measurement model fits the data well. Furthermore, path coefficients were examined to interpret the relationships among endogenous variables (i.e., eco-management type of energy conservation behavior and persuasion type of energy conservation). To do this, standardized path coefficients were examined. Standardized path coefficients are beta weights in regression, in which beta weights are interpreted as regression coefficients (Kline, 2008).

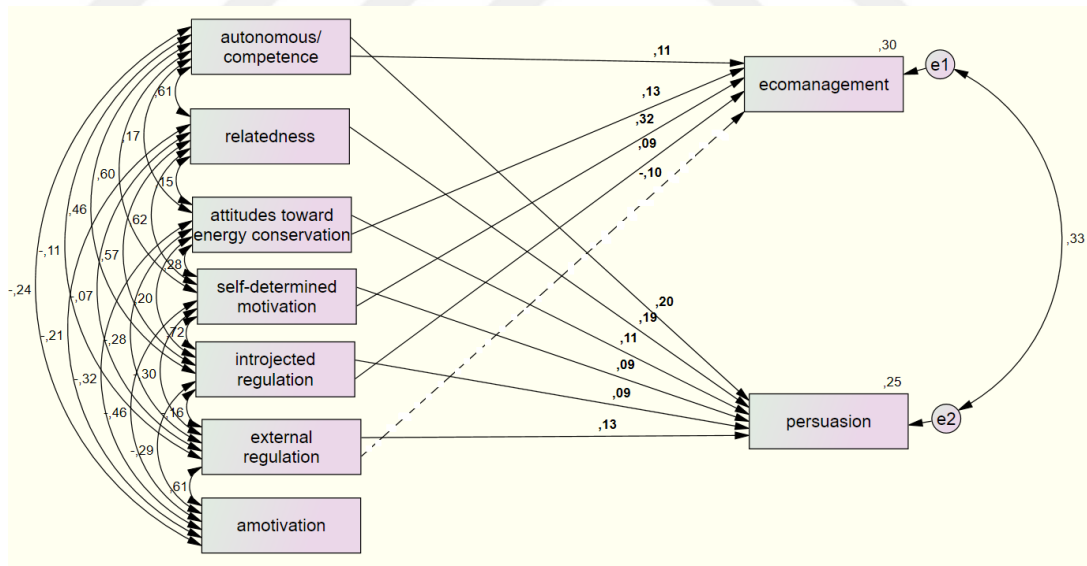


Figure 4.2 AMOS output with standardized significant path coefficients

*the dashed lines represent the negative relationships.

Table 4.7 shows the significant paths' standardized path coefficients (β), unstandardized path coefficients (Estimate), standard errors (SE), critical ratio (CR) and p values to interpret the results of path analysis. While interpreting the results, standardized coefficients (β) are used. Kline (2011) explained the reason as "Beta weights indicate the expected difference on the criterion in standard deviation units, controlling for all other predictors. Also their values can be directly compared across predictors." (p.21). As have been understood, β values are standardized estimates that enable researchers to make comparisons. Furthermore, Pedhazur (1997) claimed that the coefficient values (β) in path analysis are the r -values. Therefore, while interpreting the strength of relationships in path analysis, Cohen's criteria for effect size can be used. According to this criteria, r -value .10 is weak; r -value .30 is moderate; and r -value .50 and more is strong.

In order to find out how much variance in energy conservation behavior (ECB) of PSTs is explained with attitude, basic psychological needs and motivations toward energy conservation, a guided model was offered based on the literature. Then, regarding the exploratory and confirmatory factor analysis results, the model was improved. Following this, the model was tested in order to understand if the data fit the model and explain ECB. After testing the model, all paths are examined if they are significant. It was observed that paths from amotivation to eco-management ($\beta=.02$, $p>.05$), from amotivation to persuasion ($\beta=.05$, $p>.05$) and from relatedness to eco-management ($\beta=.05$, $p>.05$) were insignificant. These insignificant paths were removed from the model. By this way, the model is trimmed in order to improve the fit indices (Kline, 2011). After making this modification, the model was tested again. Then, the estimated parameters showed in Table 4.7 were obtained, and these results were explained below. Firstly, Beta (β) values for the paths identified for eco-management type of ECB was presented. Then β values for the paths identified for persuasion type of ECB was introduced.

Table 4.7

Parameter Estimates of Path Coefficients for Energy Conservation Behavior

Endogenous Variable	Exogenous Variable	β	Estimate	SE	Critical Ratio	p
Eco-management	Attitude toward energy conservation	.13	.10	.02	4.73	.00
	Autonomous/Competence	.11	.07	.02	3.67	.00
	Self-determined motivation	.32	.21	.03	7.62	.00
	Introjected regulation	.09	.04	.02	2.47	.01
	External regulation	-.10	-.04	.01	-3.67	.00
Persuasion	Attitude toward energy conservation	.11	.11	.03	3.84	.00
	Autonomous/Competence	.20	.16	.03	5.80	.00
	Relatedness	.19	.12	.02	5.42	.00
	Self-determined motivation	.09	.08	.04	1.93	.05
	Introjected regulation	.09	.06	.02	2.37	.02
	External regulation	.13	.07	.02	4.56	.00

In the eco-management type of energy conservation behaviors, the largest relationship was found with self-determined motivation ($\beta=.32$). The strength of the relationship was moderate. This result shows that PSTs with self-determined motivation display eco-management type of energy conservation. The relation between introjected regulation and eco-management was relatively small. Furthermore, the relation between external regulation and eco-management behavior was negative and the strength of the relationship was small. According to this result, PSTs display eco-management type of energy conservation behavior when they internalize this behavior

into their values and identity. Lastly, the relationship between attitude and eco-management behavior was found to be positive and weak ($\beta=.13$).

In the persuasion type of energy conservation behavior, the largest relation was found with basic psychological needs (Autonomous/competence: $\beta=.20$; relatedness: $\beta=.19$) in which PSTs' autonomy, competence and relatedness needs influence their persuasion type of energy conservation. When they feel competent to conserve energy willingly, and feel the support of society they live with, they persuade their environment to conserve energy. Although this relation is small, it is significant. The relationship between persuasion type of energy conservation and introjected regulation ($\beta=.09$) and external regulation ($\beta=.13$) respectively were found weak. Lastly, the relationship between attitudes toward energy conservation and persuasion types of energy conservation behaviors was weak ($\beta=.11$).

Followed by the examination of path coefficient values, squared multiple correlations (R^2) were examined to determine how much variance in eco-management and persuasion types of energy conservation behaviors were explained. The results revealed that R^2 value for eco-management was .30, and this value for persuasion was .25. This means that 30% of variance in eco-management type of energy conservation behavior was explained by the model, and 25% variance in persuasion type of energy conservation behavior was explained by this model.

4.4 Findings of Qualitative Data

Research Question: How does awareness about energy related issues explain the observed relationships among attitudes toward energy conservation, basic psychological needs and motivation toward ECB of PSTs?

In the path model, the highest correlation was found between self-determined motivation and eco-management type of ECB. PSTs' awareness of energy related problems, issues and solutions might have a role in this relationship. Therefore, PSTs' awareness was explored in this part of the study. Then, interpretations about this relationship were made.

PSTs' courses including energy resource types, the impacts of energy resources and energy conservation might contribute to their attitude, motivation, awareness and ECB. Therefore, in qualitative part of the study, PSTs were asked if their courses at university included those issues and how they were included. Consequently, the final part of this chapter included information about courses in order to understand their attitude, motivation, awareness and ECB better.

4.4.1 Awareness of energy related problems, issues and solutions

In order to explore awareness of preservice science teachers (PSTs), codes and categories were created. In this way, the data were organized to interpret the results (Miles et al., 2014). Table 4.8 shows these categories and sub-categories related to awareness. With the purpose of deriving a series of meanings from the data, the frequency of each code was calculated. In this process, each code was counted only once for each participant. That is, the frequency shows in how many participants the code was revealed.

Table 4.8

Themes and categories for awareness about energy-related problems and issues and their perceptions about solutions.

Themes	Categories/Sub-categories
Awareness about energy-related problems and issues	• Problems related to energy policies and implications • Problems related to the impacts of energy resources • Problems related to energy conservation
Awareness about the solutions of energy-related problems and issues	• Solutions related to energy policies and implications • Solutions related to technology • Solutions related to energy resources • Solutions related to energy conservation • Environmentalism

4.4.1.1 Awareness of energy-related problems and issues

Energy related-problems and issues are complex, which have multiple consequences on economy, policy, society and environment. The categories, which emerged from the open coding under this theme, revealed the following three categories: problems related to energy policies and implications, the impacts of energy resources and energy conservation. Each category and code are described below. Then, the results regarding grade level (i.e., junior and senior grade level) are presented for each category and code, followed by the interpretations made about the observed relationships in the model. These interpretations are not cause-effect relationships since the study is not experimental.

4.4.1.1.1 Problems related to energy policies and implications

The subject area of politics focuses on decisions or implications of a government, which makes decisions on the regulation and generation of energy. To illustrate, these implications may include taxes on energy consumptions, financial support for renewable energy research and development, international agreements among nations regarding energy issues and the regulations on meeting the energy demand (Cleveland & Morris, 2013; Harris & Roach, 2013). The data revealed nine codes in this category: (a) political conflicts, (b) governmental support, (c) energy consumption inequality, (d) dependence on foreign energy resources, (e) public participation in decision-making, (f) illegal electricity use, (g) electric and heating expenses, (h) increase in energy demand and (i) fundamental knowledge about energy. Table 4.9 shows the description of these codes with a representative quotation. On the other hand, Figure 4.3 displays the frequency of codes. These frequencies represent the number of PSTs, who mentioned the codes during the interview.

Table 4.9
The description of codes related to energy policies and implications

Codes	Description	Quotation
Political conflicts	Referring to wars on petroleum and conflicts over CO ₂ emissions among nations (e.g., some countries are unwilling to sign Kyoto protocol).	“I believe that some wars will start in the future. Even today, this war is happening. Countries are fighting with each other for this resource [oil] even today.” (PST2)
Governmental Support	Referring to the government’s policy for renewable energy. That is, it is thought that sufficient financial support to the commission of renewable energy resources is not provided.	“Because the government in our country wants the construction of nuclear energy power plants. By contrast, Germany is planning to shut all nuclear energy power plants. Instead, they started Green Germany project and everywhere will be covered with solar energy, forests and useful things. On the contrary, the government in Turkey favors nuclear energy power plant and if we look at their vote rate, there are so many people, who share the same view. Indeed, half of population has the same view with them. When they told that the nuclear energy is good, so many people supported them. We experienced this. In fact, they will construct the second one in Sinop. As I know, they also took permissions for Sinop. When they take the permissions, there is no return” (PST18)
Energy consumption inequality	Referring to the inequality around the world regarding access to energy. Indeed, the inequality between developed and other countries was emphasized in this code.	“There is an inequality in reaching energy. Africa has underground resources, perhaps oil. However, they cannot mine their resources because this country is not developed. However, since Europe is developed, the source in Africa is used by European countries. It is also related to economic things. If you are predominant in the economic sense, the technology is improved. Certainly, in order to produce and sustain that technology, energy is required. Therefore, since the economy of countries like Africa is not developed and the technology in these countries is not advanced, energy cannot be used efficiently.” (PST3)

Table 4.9 (Continued)

Codes	Description	Quotation
Dependence on foreign energy resources	Referring to importation of energy resources in Turkey in order to meet the energy demand.	“As far as I know, we import energy from foreign countries. As I know, the amount is very high.” (PST6)
Public participation in decision-making	Referring to problems related to government’s communication of energy policies to citizens, problems regarding active involvement of citizens in the decision making processes at all levels and the conflict between personal benefit and public benefit.	“People in European countries can show their reaction to the government. They can say that they do not want that kind of energy; they want renewable energy and do not want to harm the environment. That’s what I want to tell; they can express their reaction. In Turkey, it works differently. For example, it is intended to construct a nuclear power plant without asking the opinion of people living there and without their approval for this plant” (PST2)
Illegal electricity use	Referring to fugitive use of electricity through illegal ways.	“Fugitive electricity use is a very big problem since a lot of people use it extensively.” (PST13)
Electric and heating expenses	Referring to energy consumption bills, which are considered as high due to illegal electricity use or the reflection of this price to electricity subscribers.	“For instance, we use natural gas energy for heating. We especially pay very large amounts of money for electricity due to illegal electricity use. Average energy bill for a family is between 500-600 TL.” (PST11)
Increase in energy demand	Referring to the increase in energy need due to population increase.	“The population is increasing, so is the need for energy. Because as human population increases, new houses are being built, and energy is needed to build those houses. Besides, energy is needed to live in that house. I think this is a problem.” (PST3)
Fundamental knowledge about energy	Referring to basic knowledge of public about energy resources and energy production ways.	“Unfortunately, my family loves buying extra things. For example, they buy extra refrigerator to put more meal. I tell them it is not necessary but they do not listen because they do not know what energy is, how it is generated, what the energy sources are. They are not aware of things like these.” (PST2)

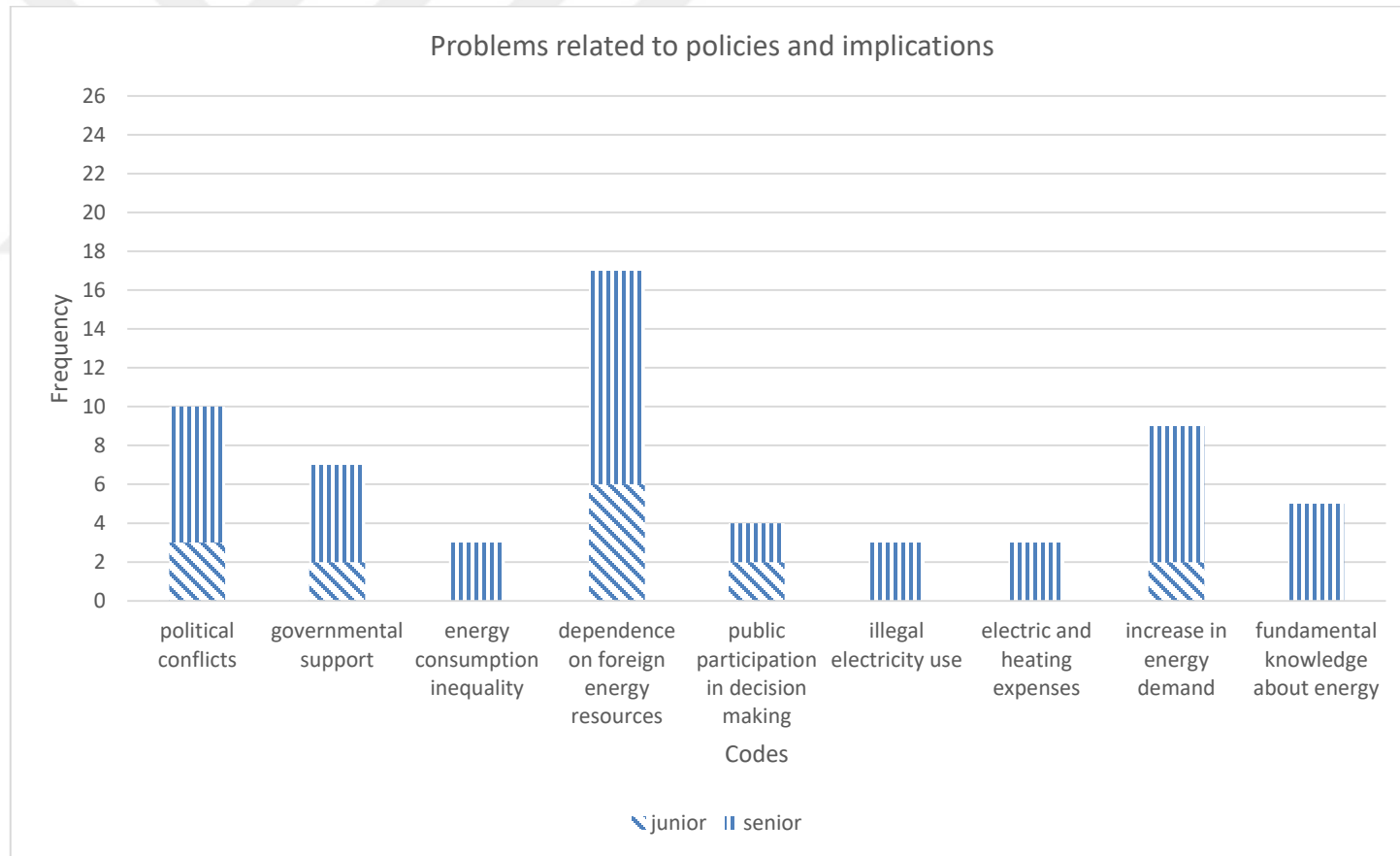


Figure 4.3 Frequencies of codes regarding problems related to energy policies and implications by considering grade level

As shown in Figure 4.3, out of twenty-six PSTs, ten PSTs were aware of the problems related to political conflicts. The reason for this result might be related to their courses. These PSTs were aware of international environmental agreements like Kyoto since these agreements might be involved in their environmental education courses. Environmental education courses with EE/ESD approach might include these types of international agreements. According to the syllabi of two universities in qualitative part, international agreements were part of the content. One of the issues in international environmental agreements is carbon emissions, which contributed to climate change. In order to decrease the CO₂ density in the atmosphere, some strategies have been developed and they have been presented to the parties to implement. Conflicts among nations are one of the serious problems in energy related policies. Another conflict PSTs mentioned was wars on petroleum in the Middle East. In addition to the courses, media might have a role in raising this awareness. The majority of PSTs mentioned the Internet and news bulletins as resource for their knowledge in energy related problems and issues. Awareness on these issues might help them rationalize their eco-management type of ECB. In this way, the relationship between self-determined motivation and ECB might be strengthened.

Governmental support is another code which emerged from the analysis. The policy of nations about energy issues such as how to meet the energy demand of nations is determined by the government. Many PSTs mentioned this problem and criticized the support of the government for nuclear energy power plant and hydroelectric power plants in energy generation. Those PSTs mostly favored sun power, wind power and biomass for energy production. Being aware of the nations' energy policy might help PSTs understand the policy dimension of this topic. However, the number of PSTs who were aware of this problem was relatively small. Therefore, the role of this awareness regarding the influence of relationships on the model might be small.

As depicted in Figure 4.3, PSTs were aware of dependence on foreign energy resources most in that more than half of the PSTs mentioned this problem during the interview.

The majority of these PSTs were senior students. This awareness might increase the relationship between eco-management and self-determined motivation. PSTs who were aware of the high percentage of energy dependence of Turkey might be more careful about energy use in their daily life. This awareness might help them internalize this behavior. However, this awareness might not contribute to persuasion behavior much. That is, they might hesitate to communicate about this problem and the importance of energy conservation.

Energy consumption inequality is mentioned by very few PSTs. According to the objectives of UNESCO (2017), one of the crucial points in sustainability is reducing the inequality among nations. However, the majority of PSTs were not aware of this problem, and the observed relationship in the model might not have been affected by it. However, if this awareness is increased among PSTs, it may contribute to the relationship between PSTs' self-determined motivation and eco-management and persuasion types of ECB.

Public participation in decision-making is another code which emerged from the analysis. In this code, PSTs thought that public should participate in decisions on energy related issues such as construction of nuclear power plants, wind power and hydroelectric power plants. This type of awareness was voiced by a small number of PSTs. Those PSTs might be aware of the role of various stakeholders in the decision-making process, and understand the importance of various dimensions (e.g., society, economy, environment). Since the number of PSTs who were aware of this problem was very small and the majority of them were from one university, the results observed in the path analysis might not have been affected by this awareness. However, if PSTs' awareness of this issue is increased, the power of the relationship between ECB types and self-determined motivation may be increased.

Illegal electricity use related problem was mentioned by a few PSTs. Therefore, this awareness might not be representative for all PSTs' awareness. That is, the observed

relationships in the model might not have been influenced. Another code which emerged from the analysis is electric and heating expenses. The number of PSTs who mentioned this problem was also very low. The majority of PSTs in the study lived with their parents or stayed at dormitories. This might be a reason why they did not mention this problem. This awareness might not be related with the relationship observed in the model.

Another code in policy and implications is the increase in energy demand. The PSTs were moderately aware of this problem. This awareness might be related with the observed relationships in the model. That is, PSTs who are aware of this problem are more likely to display eco-management type of behavior and persuade people in their society to conserve energy.

The last code is fundamental knowledge about energy. These PSTs mentioned that many people were unaware of energy resources and energy production, and for this reason, those people might use energy in a wasteful way. The number of PSTs who mentioned this problem was very low. Therefore, this code may not be related with the observed relationships in the model.

4.4.1.1.2 Problems related to the impacts of energy supplies

How energy is extracted, produced, consumed, transported, stored and disposed of influence the environment (e.g., status of earth's climate, ecosystems) and society (e.g., health of people, conflicts or wars among nations) (Cleveland & Morris, 2013). These impacts are accepted as energy-related problems. Problems related to the impacts of energy supplies are categorized considering the type of energy supplies. Therefore, sub-categories emerged in the analysis. These sub-categories are: problems related to (a) fossil fuels, (b) renewable energy, (c) hydroelectric power plants, (d) wind power

plants, (e) wave power and (f) nuclear energy. Although hydroelectric, wave and wind power plants are renewable energy resources, specific problems about these renewable types emerged from the interviews. Therefore, sub-categories specific to these renewable energy resources were created. In the category of problems related to renewable energy, PSTs did not make a differentiation and they mentioned their general awareness.

4.4.1.1.2.1 Problems related to fossil fuels

Among energy resources, oil, coal and natural gas are called as fossil fuels since these resources take form in millions of years through decaying processes of ancient plants and animals which were exposed to severe heat and pressure (Miller & Spoolman, 2012). The majority of energy needs of industrialized countries mainly depend on fossil fuels (Titenberg & Lewis, 2015). Using fossil fuels as an energy resource has several impacts. Four main codes emerged from the analyses considering the problems related to fossil fuels: (a) depletable resources, (b) environmental impacts, (c) social impacts and (d) problems related to economy.

Table 4.10

The description of codes related to problems related to fossil fuels

Codes	Description	Quotation
Depletable resource	Referring to limited quantity feature of fossil fuels.	“It is very likely that the fossil fuels will be finish and we need a very long time period to get these fossil fuels again. If we continue exploiting them, they will finish one day.” (PST8)
Environmental impacts	Referring to the impacts of using fossil fuels on the environmental sustainability through air pollution and global warming	Carbon dioxide emission is a problem since it causes global warming and climate change. Then, unusual things happen in climate. It is not only about the temperature increase or about drought, the climate is getting abnormal. Floods and storms also occur. I relate our current situation to this problem. For example, it rains heavily in the middle of summer or it snows unexpectedly. I think carbon dioxide emissions and climate change lead to these changes.” (PST4)
Social impacts	Referring to the impacts of using fossil fuels on the society through health problems, impacts to livelihood and climate migration problems.	“Because of the climate change, glaciers are melting and the level of water is increasing. For that reason, people living on the coast will have to migrate....When they have to migrate, they lose their jobs. Maybe they have to leave their agriculture lands and lose their jobs...Then, people may enter a competition when the space and food are limited. Maybe this is a utopic scenario, but maybe because of climate change migrations, people will even kill each other for limited resources. Even a war will start.” (PST4)
Problem related to economy	Referring to exploration cost of oil and the price paid for exported oil. Few PSTs mentioned this problem.	“The cost of oil is really expensive [in our country] compared to other countries. In fact, the prices show a variation between cities. Anyway, for example, we hear that while the citizens in foreign countries buy oil for 1 Turkish Lira, we buy it for 5 or even 10 Turkish Liras. I mean there is really a major difference.”

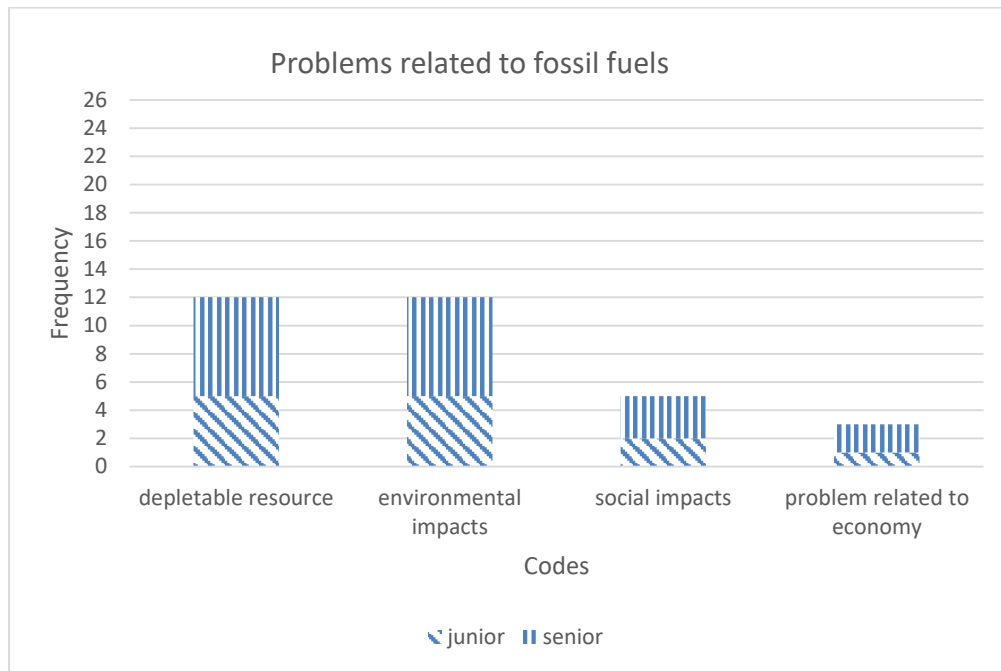


Figure 4.4 Frequencies of codes regarding problems related to fossil fuels

According to the findings in Figure 4.4, the most-frequently mentioned problem related to fossil fuels was the depletable nature of these resources. Many PSTs were aware that fossil fuels are depletable resources. Being aware of this feature might contribute to the relationship between self-determined relationship and eco-management behavior. However, this awareness might be ineffective in the relationship between self-determined motivation and persuasion behavior.

Another problem mentioned by several PSTs was the environmental impact of fossil fuels such as air pollution and global warming. Being aware of this problem might increase the relationship between self-determined motivation and eco-management behavior. Those PSTs who know these impacts might rationalize the importance of energy conservation in this way, and they might internalize this behavior. This internalization might reflect on their eco-management type of ECB. However, this awareness might not be sufficient to persuade other people to conserve energy.

The social impacts of use of fossil fuels such as health problems and climate change mitigation were mentioned by a limited number of PSTs. One of these PSTs at junior grade level experienced the effects of thermoelectric power plant in her hometown. Through this experience, she might build an awareness about this problem. Since the number of PSTs being aware of this issue was small, it is believed that it might not influence the relationship between self-determined motivation and ECB.

The last code in this category is problems related to economy. The number of PSTs who mentioned this code was very few. Many PSTs favored the use of renewable energy. Therefore, these PSTs may not favor the exploration of petroleum and that might be a reason why many PSTs did not perceive it as a problem. This code might not influence the observed relationships in the model since very few PSTs cited this problem.

4.4.1.1.2.2 Problems related to renewable energy

PSTs reflected their general concerns related to renewable energy in this category. Common problems among renewable energy resources were emphasized. Three main codes (i.e., limited use of renewable energy, problems related to economy and environmental impacts) emerged from the analysis regarding this category. Table 4.11 shows the description of these codes. Figure 4.5 displays the findings.

Table 4.11

The description of codes regarding problems related to renewable energy

Codes	Description	Quotation
Limited use of renewable energy	Referring to use of renewable energy resource types in Turkey is not widespread.	“Three sides of our country is surrounded by sea, and four seasons is lived in our country. However, we do not get much benefit from the sun.” (PST23)
Environmental impacts	Referring to carbon footprint of renewable energy resources during the production phase.	“In order to generate energy from renewable energy resources, some amount of energy is used. For example, solar panels. I do not know exactly what materials are used in the process but in order to produce solar panels, these materials have to be produced; maybe there are some chemical process. I mean there is energy use in this process and if the plant produces these materials with fossil fuels, it harms the nature.” (PST2)
problem related to economy	Referring to high investment costs of renewable energy.	“I think it is a problem for everyone [all countries] because renewable energy sources are generally cost much. I think the general problem is that there is a lot of renewable energy available but it is not preferred due to the high cost and not profitable over the long term [for energy companies]” (PST1)

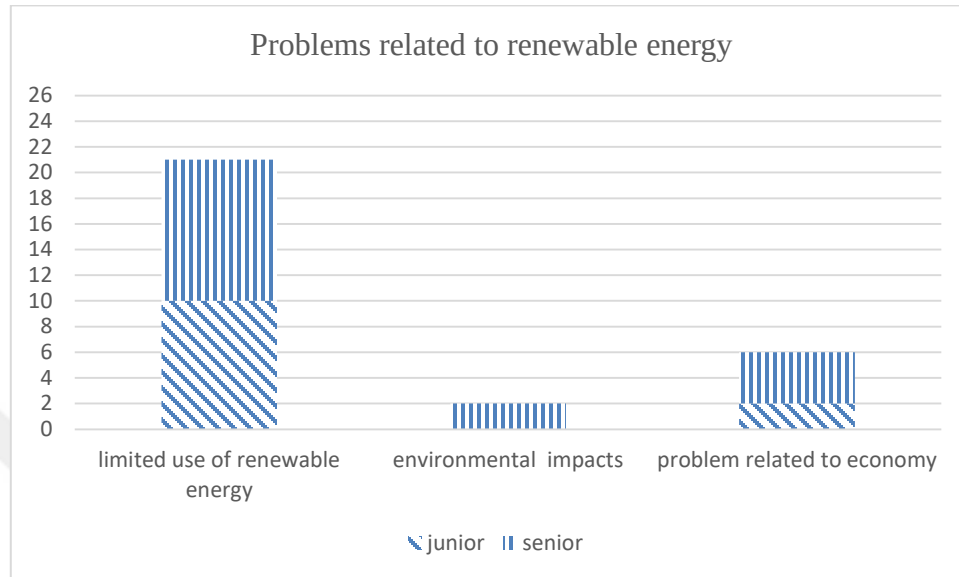


Figure 4.5 Frequencies of codes regarding problems related to renewable energy

According to Figure 4.5, a large number of PSTs cited this problem. The majority of these PSTs mainly mentioned the limited use of sun and wind power. PSTs with this awareness might display more eco-management behavior since the limited use of renewable energy led to the use of fossil fuels. In order to decrease the negative effects of fossil fuels, they might display eco-management behavior. In a similar vein, many PSTs were aware of the environmental impacts of fossil fuels as mentioned above. Therefore, this awareness might have a role in the relationship between self-determined motivation and eco-management type of ECB.

By contrast, environmental impacts of renewable energy were mentioned by a small number of PSTs. The carbon footprint of renewable energy resources during the production phase was mentioned by those PSTs. Environmental impacts of specific renewable energy resource types were also mentioned by few PSTs, who were mainly seniors. It can be concluded that many PSTs were not aware of the environmental

impacts of renewable energy types. Therefore, this awareness might not have a role in the observed relationships in the path model.

Problems related to economy were mentioned by some PSTs. Those PSTs thought that renewable energy resources could be expensive to generate energy. This awareness might be helpful for PSTs to rationalize eco-management type of renewable energy and increase their eco-management type of ECB.

4.4.1.1.2.3 Problems related to hydroelectric power plants

PSTs voiced their concerns specific to hydroelectric power plants in this category. It was revealed that their concerns were related to environment, society and planning of hydroelectric power plants. Table 4.12 shows the description of these codes, and the results are shown in Figure 4.6

Table 4.12

The description of codes regarding problems related to hydroelectric power plants

Codes	Description	Quotation
Environmental impacts	Referring to the impact of hydroelectric power plants on the environment through disruption of nature, destruction of ecosystems, local climate change, fish migration, change in flora, decrease in flow rate in the river, change in harvest time, change in animals' living zone, and tree cutting.	"I saw the construction phase of the hydroelectric power plant. The roads are broken, huge trucks were working, and air pollution was happening. A lot of tree was cut at this stage... Then after its installation, everything seems normal firstly but in one or two years, I observed that the flow rates of rivers lower. However, these rivers used to flow fast...It was very difficult to pass over these rivers by walking because they were deep but now they are as shallow as that you can pass the river without getting wet. I mean they are not flowing copiously" (PST10)

Table 4.12 (continued)

Codes	Description	Quotation
Social impacts	Referring to the impacts of hydroelectric power plants on the livelihood of local people, historical structure, public health and agricultural land of farmers.	“Çine stream is located on a historical place in my hometown. There was a tied-arch bridge. After the construction of hydroelectric power plant in that area, the water level increased gradually and ancient bridge was flooded. Everything is gone, it is very sad.... We are experiencing extreme humidity and it makes difficult to breath. My mum has asthma bronchitis and that humidity makes her uncomfortable. This humidity is also increased because of the hydroelectric power plant” (PST9)
Planning of hydroelectric power plants installation	Referring to installation of high number of hydroelectric power plant on a river and inappropriate location choice.	“Hydroelectric power plants should not be established intensely. For example, if there are ten rivers in Giresun, they build hydroelectric power plants on each river. I can understand the reason when they build one but they construct it on each of river.” (PST10)

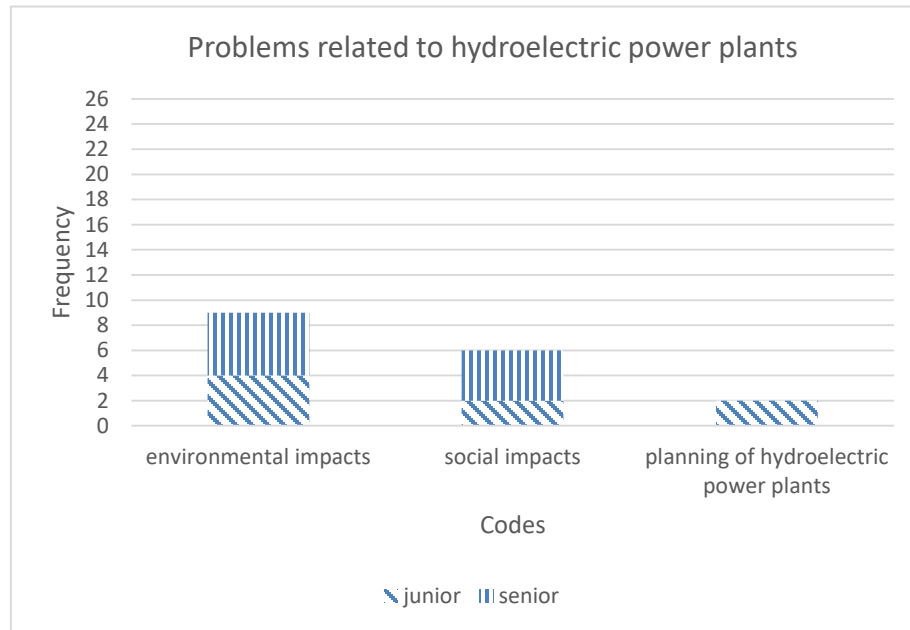


Figure 4.6 Frequencies of codes regarding problems related to hydroelectric power plants

Among the impacts of hydroelectric power plants, the mostly-mentioned problem was environmental impacts. Less than half of the PSTs mentioned this problem. However, the majority of the PSTs were not aware of this problem. The PSTs in University A told that cases and documentaries related to hydroelectric power plants were involved in the environmental education courses. Besides, construction of hydroelectric power plants was discussed as an issue in the STS course. Those courses might have a role in this awareness. Furthermore, one of the PSTs who mentioned this problem told that she watched documentaries related to energy problems and issues related to hydroelectric power plants on TV. Another PST told that she observed the environmental impact of these plants on a trip she took with her family. Some of these PSTs told that they watched this problem on the Internet and news bulletins. Besides courses, documentaries, the media and personal experiences might have a role in raising the awareness related to environmental impacts of hydroelectric power plants. This awareness might play a role in the internalization of eco-management type of ECB. In this way, the relationship between self-determined motivation and eco-management might be increased.

Awareness of social impacts of hydroelectric power plants was mentioned by few PSTs. Some of them told that they discussed the impacts of these plants on the sources of income for people in their environmental education courses through cases and documentaries. Two of them who mentioned this problem knew the social impacts of these plants since their hometown experienced this problem, and they observed the impacts. PSTs having awareness of the social impacts of hydroelectric power plants might have rationalized the importance of energy conservation and internalize this behavior. In this way, the relationship between self-determined motivation and eco-management type of ECB might be increased.

The last code is the planning of hydroelectric power plants. This code emerged from the data from two PSTs whose hometowns had hydroelectric power plants, and they observed the impacts of these plants on environment and society. Furthermore, they

told that their hometowns were still under serious pressure about construction of many hydroelectric power plants. Therefore, these PSTs were aware of a planning problem regarding the number of hydroelectric power plants and their locations. They gained this awareness through individual experiences. The majority of PSTs were unaware of this problem. Therefore, this awareness might not have influenced the observed relationships in the model.

4.4.1.1.2.4 Problems related to wind powers plants

PSTs indicated problems specific to wind power plants in this category. The analysis showed that few PSTs had environmental and social concerns about wind power plants. Table 4.13 shows the description of these codes, and Figure 4.7 displayed how many PSTs mentioned this problem.

Table 4.13

The description of codes regarding problems related to wind power plants

Codes	Description	Quotation
Environmental impacts	Referring to environmental impacts of wind power plants on animals and cutting of trees	“The villagers complained about that they could not graze their cows since the amount of grass decreased around the wind power. Furthermore, they told that their cows did not want to go around the wind power. The villagers had this kind of concerns” (PST10)
Social impacts	Referring to the impacts on livelihood of people through the noise and the lands taken from villagers.	“As I remembered it was in Izmir. The villagers complained about the constant voice of the wind power in their village” (PST9)

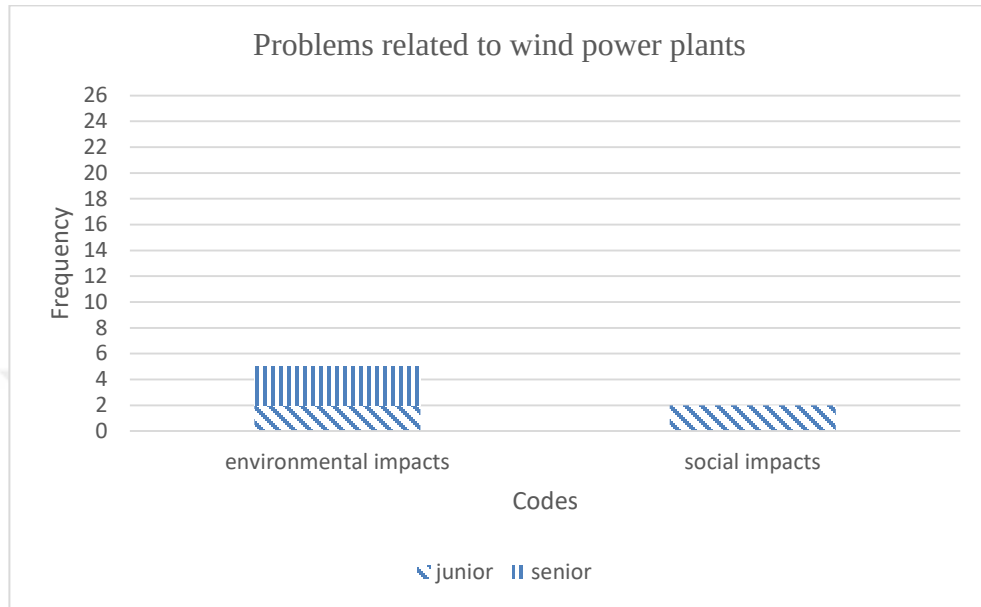


Figure 4.7 Frequencies of codes regarding problems related to wind power plants

The findings revealed that environmental impacts of wind power plants were mentioned by a small number of PSTs. Among those, one of them observed this problem in a village, which is close to her hometown. The majority of the PSTs might not be aware of this problem. For that reason, this awareness might not influence the relationships in the path model.

The other code which emerged from the analysis related to wind power was the social impacts of wind power plants. This problem was mentioned by two PSTs, who observed this effect in their neighborhood and in a documentary. Many PSTs might not be aware of this problem. Therefore, the relationships in the path model might not have been affected by this awareness.

4.4.1.1.2.5 Problems related to wave power plants

The results revealed that except for one participant, the PSTs did not mention any problems related to wave power plants. Only one PST presented his environmental concern for wind power plant. Environmental impact refers to the impact of wind powers on environment by influencing the environment of fish. PST1 indicated this problem as displayed below:

“Wave energy may cause some problems if it is installed in an area where fish population is intense. It may affect their habitat.”

Many PSTs were not aware of the problems related to wave power plants. This renewable energy is not used commonly in Turkey. Therefore, they might be unaware of the problems related to it. Since the majority of the PSTs were not aware of this problem, relationships in the path model might not have been affected by this awareness.

4.4.1.1.2.6 Problems related to nuclear energy power plants

PSTs indicated their concerns specific to nuclear power plants in this category. The analysis revealed four main codes, i.e. environmental impacts, problems related to economy, risk perception, and management of nuclear energy power plants. Description of these codes is presented in Table 4.14. The frequency of codes is displayed in Figure 4.8.

In terms of environmental impacts, the number of PSTs who mentioned this issue was very small. Therefore, this awareness might not have a role in the relationships observed in the path model. Another code in this category is problems related to

economy, which was mentioned by a few PSTs from University A. Since the number was small, the relationships in the model might not have been influenced by this code.

Table 4.14

The description of codes regarding problems related to nuclear energy power plants

Codes	Description	Quotation
environmental impacts	Referring to the effects of radiation on environment or the effects of cooling process of nuclear power plants on aquatic animals.	“Due to the hot water released from nuclear energy power plant can change the environment of aquatic animals and perhaps many of them will die.” (PST1)
problems related to economy	Referring to high investment costs of nuclear power plants or concerns about if it is a profitable investment.	“Is it [nuclear energy power plant] really a profitable investment or is it done for something else? I think it is a problem too” (PST3)
risk perception	Referring to accidentally happened or unexpected situations (e.g., accidents, explosions) and the consequences of those situations to environment and people.	“There will be a radiation field or something [around the nuclear energy power plant], and many people living in the environment will be harmed. I have such concerns like this.... Because of Chernobyl accident, the Black Sea region was affected from the consequences a lot. I was not born yet when the accident was happened but my mum told about it. She told that all tealeaves were covered with white and they did not drink tea in that year. Because of the accident, the cancer rate is increased. For example, many children born in that year and after that year caught cancer. The effect of radiation is still continuing for years.” (PST10)

Table 4.14 (continued)

Codes	Description	Quotation
Management of nuclear energy power plant	Referring to planning phase of nuclear energy power plant (i.e., precautions taking in advance to prevent accidents) and management of the radioactive resource acquisition, radioactive nuclear waste, dismantle of the plant or concerns about the lack of national authority over these plants.	“As I know, life time of a nuclear power plant is 60 years or so, after 60 years it must never be operated. There is an installation process of the power plant, during the operation process there is damage to environment, and what to do after it is closed. It is told [about Akkuyu nuclear power plant] that the last technology will be used and such features of it certainly prevent any leak and etc. However, as a society, can we really manage this? First, we do not manage the plant. Its management is already given to a foreign company; we gave it to Russians. We do not have the control over the operation. When those guys are managing that we will not actually be aware of anything, we just plug in the cable and the power plant gives us energy, but I think we will not be aware of what happens in that plant. Because we do not manage it.” (PST5)

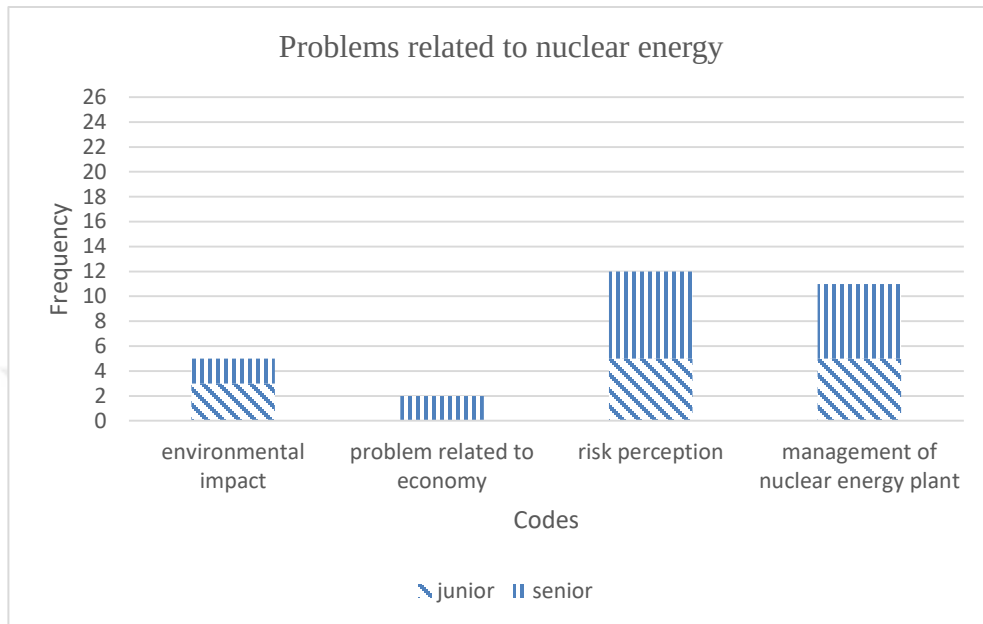


Figure 4.8 Frequencies of codes regarding problems related to nuclear energy power plants

The findings showed that PSTs focused on the risks arising from nuclear energy power plants. Those risks include possible accidents and explosions. A nuclear energy power plant as an issue has been on the agenda of Turkey recently. Therefore, this issue was involved in the media and PSTs might watch the news and discussions about the risks of nuclear power plants. In addition to this, this issue is widely used in argumentation teaching method to exemplify how this method can be used in science teaching. The PSTs in University B told that their method course involved this issue and they discussed this issue with their classmates in the course. The PSTs in University A told that in their STS course they discussed this issue from the perspectives of multiple stakeholders by using the argumentation method. Both the media and the courses might have a role in this awareness. Having risk perceptions on this issue might contribute to PSTs' rationalization of energy conservation, and their eco-management type of ECB

might be increased. In this way, the relationships between self-determined motivation and eco-management type of ECB might be increased.

The last code which emerged from the analysis was the management of nuclear energy power plants. The PSTs were aware of the problems related to radioactive resource allocation, waste regulation, dismantle of the plants and lack of national authority in the management of these plants. This awareness might have a role in the relationship between self-determined motivation and eco-management behavior.

4.4.1.1.3 Problems related to energy conservation

Problems related to energy conservation involve energy wasting and awareness about the consequences of this problem (Harris & Roach, 2013). The analysis revealed two main codes in this category: (a) wasteful use and (b) unawareness of energy conservation.

Many PSTs were aware of wasteful energy use. They might observe this problem in their society. In addition to this, some PSTs mentioned the importance of carbon footprint activity they experienced in their environmental education courses in this sense. They told that their awareness of wasteful use increased with this activity and they discussed how to decrease carbon footprint in the class. Having awareness about this problem might help PSTs to internalize their ECB and they might increase their eco-management type of ECB by learning how to decrease carbon footprint. In this way, the relationship between self-determined motivation and eco-management might be increased.

Table 4.15

Problems related to energy conservation

Codes	Description	Quotation
Wasteful Use	Referring to use of energy carelessly or extravagantly through consuming energy resources too much, loving to buy extra stuff, using plastic bags excessively, leaving chargers in the power outlets, and energy waste in lighting.	“We are wasting too much energy. In fact, I do not think people save energy at homes. Electricity is being used from morning to night in vain. Instead of using sunlight during daytime, electricity is used. As a result, it is wasted in vain. In this respect, we will live serious energy problems in the future.” (PST25)
Unawareness of energy conservation	Referring to ignorance of people about the importance of energy conservation.	“We are unconscious about use of energy. For example, we buy air conditioning, although it is unnecessary in Ankara. I have a relative having two air conditioning in their home. It is not necessary indeed. We like wasting as a nation. In fact, as a nation we do not think what would happen next, what we leave to future generations. It is related to being unconscious” (PST2)

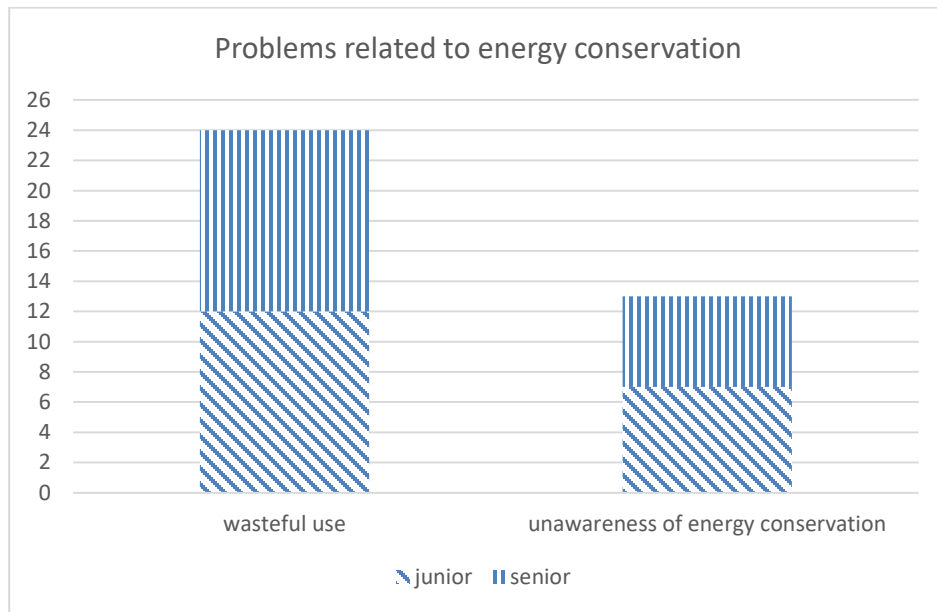


Figure 4.9 Frequencies of codes regarding problems related to energy conservation

Another code which emerged from the analysis was unawareness of energy conservation. Many PSTs mentioned that people in the society were unaware of the importance of energy conservation. However, the frequency of this code was lower than that of wasteful energy use code. Some PSTs might be unaware of this problem and this might be a reason for the insignificant relationship between self-determined motivation and persuasion behavior. PSTs with self-determined motivation and awareness of this problem might be more willing to persuade other people to conserve energy by increasing their awareness of this problem.

4.4.1.1.4. Awareness of the relation between energy use/production/conservation and global warming

Studies have showed that the density of carbon dioxide in the atmosphere is an agent in climate. Using fossil fuels in energy generation and transportation causes a constant increase in CO₂ levels. (Cleveland & Morris, 2013). This category reflects the understanding participants about climate change. In other words, it aims to reveal if the participants can make a connection between energy use and global warming or climate change. The following six categories were created in order to describe their understanding.

Table 4.16

Description of codes related to awareness of relation of energy use/production/conservation with global warming

Codes	Description	Quotation
Code A	No relationship: PSTs do not indicate a relationship between energy use/production/conservation and global warming or climate change.	"I think it does not affect climate change. I am thinking... We used to use coal for heating at houses but we use natural gas now and we have cleaner air and environment but I do not think this affect climate change. I think there is no relationship." (PST14)
Code B	Identify/describe only problem or effect: PSTs only mention global warming or climate change or energy use/production/conservation but cannot link the relationship among them.	"I think there is a change in climate... This may be related with energy use since we cause harm to nature... For example, there are energy generation plants and if we look the construction areas of these plants, they destroy the environment... In order to construct a plant trees are cut and animals living in that are affected and there is a direct harm on environment..." (PST12)
Code C	Identify only general relationship: PST answer the question as yes/no that s/he does not make any explanation or does not provide any example.	"I think energy use and climate change are related. Carbon emissions can influence climate change, I think. There is a negative release into the environment, this can affect the environment, and because of this, some changes can happen... Energy conservation and climate change are related. That is, we can decrease the negative influences on environment if we conserve more energy" (PST17)
Code D	Link problems to causes and Link problems to solutions: PSTs can describe the relationship between energy use/production/conservation and global warming or climate change. The representative example for this code:	"While generating energy from fossil fuels, the gases revealed from this process cause global warming and gives harm to nature. For example, due to CO ₂ and the other harmful gases revealed from thermal power plant, the heat stays longer at earth and these gases global warming. Depending on this global warming, droughts can be seen or the rainfall intensity can be getting lower or the time for rainfall can be changed. Furthermore, in terms of energy use, energy demand can be increased due to unnecessary energy use. Therefore, the need for generating energy is increased and the density of gases I mentioned before were increased in the atmosphere. If we save energy, we can decrease climate change. For example, when we turn off electrical devices when we do not use them, we save energy and we help decrease the energy demand. In this way, we can decrease the use of fossil fuels used in power plants. In this way, the harmful gases can be decreased and we can decrease the effect of CO ₂ and the other gases harmful effect on climate change." (PST1)

Table 4.16 (continued)

Codes	Description	Quotation
Code D1	Inaccurate link problem to causes and solutions: PSTs describe an incorrect relationship between energy use/production/conservation and global warming or climate change. For example, rationalizing this relationship with air pollution, ozone depletion or nuclear accidents.	“Energy and climate change... I can give the example of Chernobyl explosion, which caused great changes there. The climate changes there and its effects are still said to be continuing. The trees and the forests are still under the influence of chemical matters. If we do not use energy properly, it influences our climate.” (PST19)
Code D2	Linking problem to causes but cannot link problem to solution: PST described the relationship between energy use/production and global warming or climate change but ignoring the mitigation effect of energy conservation and anthropogenic effects and rationalizing global warming or climate change with a natural process.	“There may be a relationship between energy and climate change. The amount of energy we consume can adjust the speed of climate change. For example, if we use too much energy, I mean if we waste too much, it will cause global warming 100 years. Energy waste can accelerate things. There may be such a relationship between energy use and climate change... In fact, since the formation of universe, there is a magnificent chaos and nothing is regular. In addition, I do not believe that climate change is the product of people. Because our world was in the glacial period about 500 thousand years ago. Everywhere was covered with ice up to the Black sea land...After this period, the world entered the warming phase...In deed, the world is unstable. That is, people may trigger the global warming but I do not think they are the main factor. Their effect may be a step or a trigger. I mean this is a natural process and people’s activities are not the major factor... When we use energy, CO ₂ gas is released into the atmosphere. CO ₂ is a very effective heat-trap, which keeps the heat in the atmosphere. We released great amount of CO ₂ into the atmosphere from earth. I mean too much use of petroleum or too much use of energy is resulted in great amount of CO ₂ emissions and this affect the global warming indirectly. Just I told, it is only a trigger.... I do not think we can change the climate with using energy. When we save energy, we do not use the thing, which is already in nature... When we conserve energy, it would not help to heal nature. Whether we save energy or not, it will stay as nature.” (PST11)

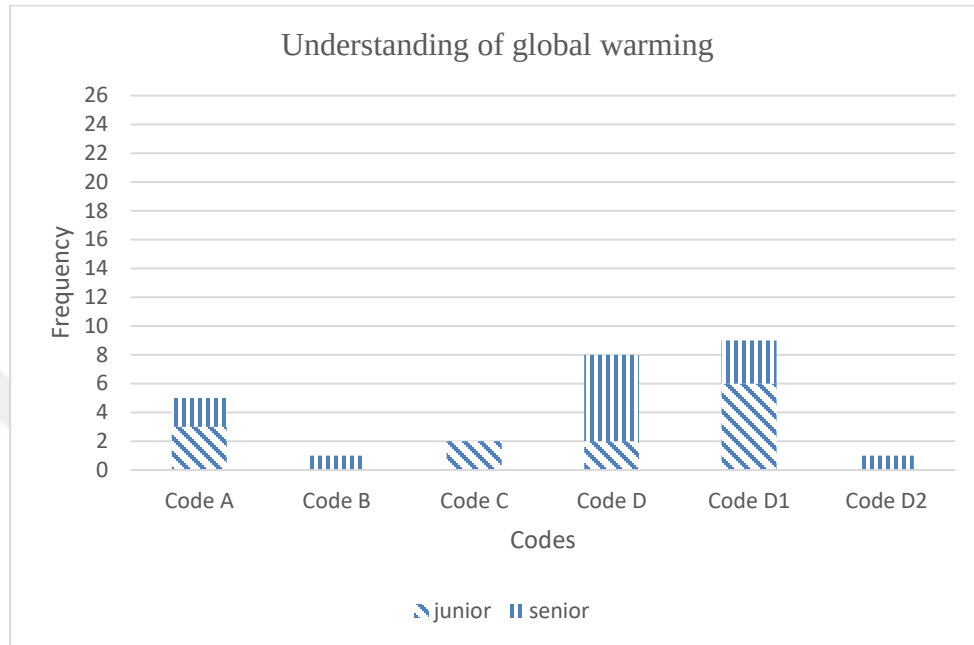


Figure 4.10 Frequencies of codes regarding the understanding of global warming

Among these six codes, only Code D represents correct understanding about the relationship between energy use/production/conservation and global warming or climate change. The results showing the understanding of PSTs about the relationship between energy topic and global warming are summarized in Figure 4.10. It was found that eight PSTs out of twenty-six responded correctly to the question regarding this relationship. The number of PSTs having this awareness was rather low. However, the majority of PSTs were aware of the environmental impacts of fossil fuels. Even if they had misconceptions about this relationship, they might rationalize this behavior through the impacts of fossil fuels on global warming and air pollution. Hereby, the relationship between self-determined motivation and eco-management might be increased.

4.4.1.2 Awareness about solutions of energy-related problems and issues

Energy-related problems and issues are multi-dimensional. Hereby, their solutions are also related with economy, policy, society and environment. Supporting this argument, five categories emerged, which reflect this multidimensional feature: (a) solutions related to energy policies and implications, (b) solutions related to technology, (c) solutions related to energy resources, (d) solutions related to energy conservation and (e) environmentalism.

4.4.1.2.1 Solutions related to energy policies and implications

This category refers to participants' perceptions regarding solutions which are managed by government support, and which require communication between citizens and the government. The results revealed the following codes under this category: (a) governmental support (b) public participation in decision-making and (c) decreasing foreign energy dependence. Descriptions of these codes were presented in Table 4.17

Table 4.17

Descriptions of codes related to solutions about policies and implications

Codes	Description	Quotation
Governmental support	Referring to financial support to renewable energy resources as a solution to energy related problems and to the priority of government over public and environment health in decisions.	“As I know, five or six years ago, German government encouraged the citizens through credits to use automobiles having less carbon emissions. I know this from my brother living in German. I mean that if the productions of these tools are spread and if the government support people, the use of petroleum can be decreased” (PST2)
Public participation in decision making	Referring to effective communication of the government to citizens regarding energy policies or active involvement of citizens in the decision-making processes through informing the public about nuclear power plants, and enabling local people to participate in the decisions of energy related issues.	“I think this nuclear energy problem can be solved in an ideal environment. For example, scientists, politicians and local people come together; discuss the issue, and then they can arrive at a decision.” (PST3)
Decreasing foreign energy dependence	Referring to decrease in the amount of imported energy through use of renewable energy resources.	“We have to produce energy. As long as we do not think on alternative solutions, we will have to be dependent on energy and it will lead negative consequences” (PST2)

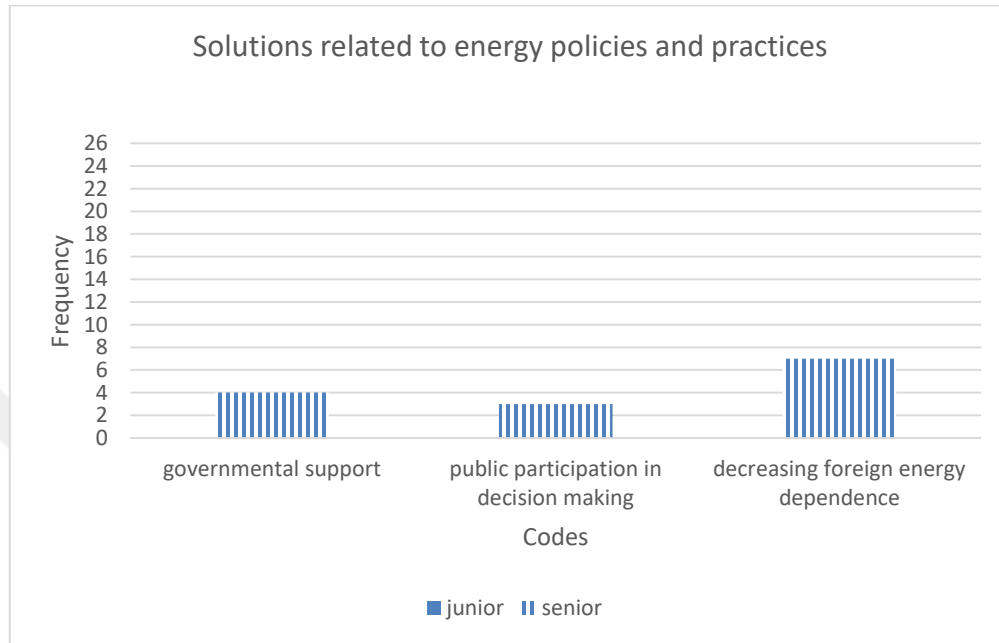


Figure 4.11 Frequencies of codes regarding perceptions about solutions regarding energy policies and practices

According to Figure 4.11, the majority of PSTs did not mention solutions related to energy policies and practices. Among these solutions, the most mentioned solution is decreasing foreign energy dependence followed by governmental support and public participation in decision-making. Those who were aware of this type of solutions were senior students who were also aware of some problems related to policies and implications. As mentioned before, the environmental education courses with EE/ESD approach and the STS course might have a role in raising this awareness. Since these codes were mentioned by a small number of PSTs, they may not be representative of the awareness, which influences the relationships in the model.

4.4.1.2.2 Solutions related to technology

In this category, developments in technology regarding energy efficacy and energy production which may resolve the energy demand problem were mentioned. The specified codes for this category did not emerge from the analysis. An example for this category is as follows:

“Since the technology is advancing rapidly, there is a hope for energy production to meet the demand in the future.” (PST7)

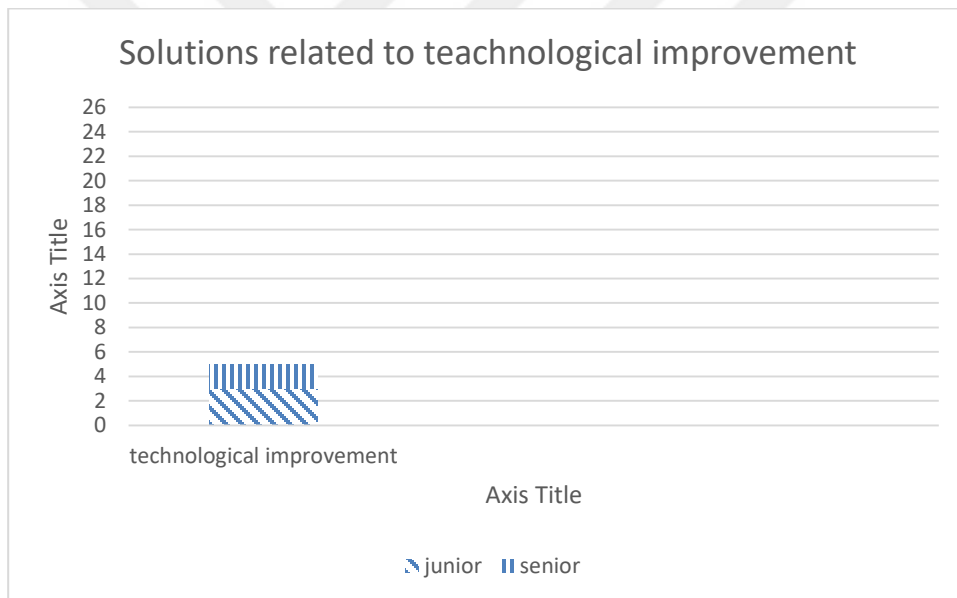


Figure 4.12 Frequency of solution related to technological improvement regarding the universities and grades

The findings revealed that very few PSTs were aware of the solutions related to technological improvements. Solutions of energy related problems related to technology might be complex issues for the content of courses of PSTs. Therefore, PSTs might not have thought about this type of solutions during the interview. Many

PSTs did not mention this solution and it might not have a role in the strength of the relationships observed in the path model.

4.4.1.2.3 Solutions related to energy resources

The process of energy generation has several impacts on environment and society. Solutions related to energy supplies refer to the perceptions of participants about how to prevent or lessen these impacts. Two main categories emerged: (a) renewable energy and (b) nuclear energy. Descriptions of these codes are presented in Table 4.18.

4.4.1.2.3.1 *Renewable energy*

As shown in Figure 4.13, almost all PSTs mentioned renewable energy resources as a solution to the energy-related problems. In terms of renewable energy types, the most mentioned was sun power and wind power. Hydroelectric power plants were mentioned as a solution by few PSTs. Indeed, some PSTs stressed that they do not classify hydroelectric power plants as a renewable energy type since they harm the environment. Some PSTs might have misunderstanding about the classification of renewable energy types. Favoring renewable energy resources for energy related problems and issues might be related to concern for environment. People favoring this energy resource with this type of concern might have self-determined motivation for energy conservation and display more eco-management type of ECB. In this way, the relationship between self-determined motivation and eco-management type of ECB might be influenced positively.

Table 4.18

Descriptions of codes related to solutions about energy resources

Categories	Codes	Description	Quotation
Renewable energy	Favoring Renewable energy	Referring to wind power, wave power, sun power, hydropower, biomass, geothermal and hydrogen energy as a solution to energy-related problems or as an employment area in energy sector.	“Instead of constructing hydroelectric power and nuclear energy power plants, we should tend towards sun power.” (PST10)
	Convenient type of renewable energy installation	Referring to installation of renewable energy resources by considering the geographical and climate features of regions.	“Each region in Turkey has their specific climate and geographical properties. By considering the features of each region, the most appropriate renewable energy type should be used. For example, regions with having long sunny duration should use sun power, regions having wind potential should use wind energy.” (PST2)
Nuclear energy	As a solution	Referring to suggestion of the use of nuclear energy power plants as an energy supply.	“Nationally, we took a step to construct a nuclear energy power plant. I am actually a supporter of it because in that plant, enormous amounts of energy will be generated... We can easily meet the energy need with this plant easily. There are hazards, but there are precautions as well. I am not against it; nuclear power can be established.” (PST11)

Table 4.18 (continued)

Codes		Description	Quotation
Nuclear energy	Planning the safety	Referring to safety precautions, which model the possible scenarios and solutions about how to prevent these possibilities, and use of advance technology.	“I watched a documentary on a nuclear power plant, which is being constructed in France. An advance technology is being used in the plant and they have taken all precautions against radioactive leak.... It will contribute significantly to meeting the energy demand of France. Each possible scenario was thought and simulations and calculations were all considered during the planning phase... I do not know if the details and planning were thought like this documentary in here... But the risks can be decreased with planning in this way at least.” (PST1)
	Economic benefit	Referring to the benefit of public regarding decreasing foreign energy dependence and paying less for energy. The illustrative quotation for this code:	“The construction process [of nuclear energy power plant] has been started. Will our dependency to foreign energy sources be end or will people benefit from them i.e. will they use cheaper energy? For example, will an electricity bill of 200TL be 150TL? Now that we construct these power plants and huge amounts of money are spent. In the end, people should benefit from this plant somehow. At least we should see something. If everything remains the same, the bills increase then there is no logic in this. Furthermore, the nearest settlements to the plant will be in constant threat. The risk increases without any benefit. The people could be convinced if they see concrete results.” (PST1)

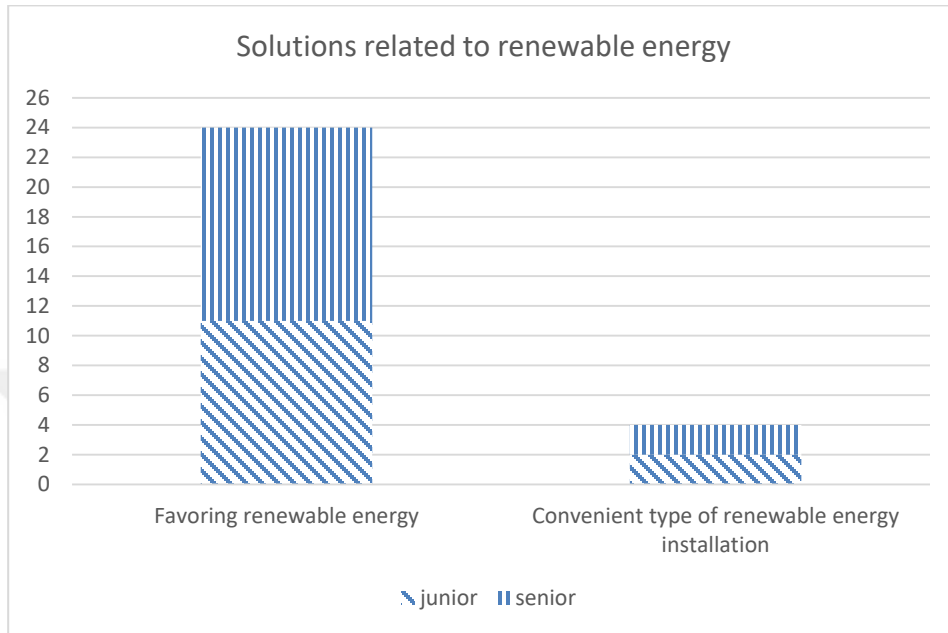


Figure 4.13 Frequencies of codes regarding the solutions related to renewable energy

Besides favoring renewable energy, a minority of PSTs addressed the importance of using convenient type of renewable energy. Those PSTs emphasized the crucial role of local features in the production of solutions to energy problems and issues. The number of PSTs who mentioned this code was very few. Therefore, this awareness might not have a role in the strength of the relationships in the path model.

4.4.1.2.3.2 Nuclear energy

Three main categories emerged in the analysis: (a) as a solution to energy problem, (b) planning the safety, and (c) economic benefit. The majority of the PSTs did not suggest nuclear energy as a solution to the energy-related problems, but a few of them thought that nuclear energy could be a solution. Therefore, a distinct code, *as a solution to the*

energy problem, was created to make visible how many PSTs mentioned it. Besides this code, planning safety and economic benefit codes emerged from the analysis. The frequencies of codes regarding grade level are shown in Figure 4.14.

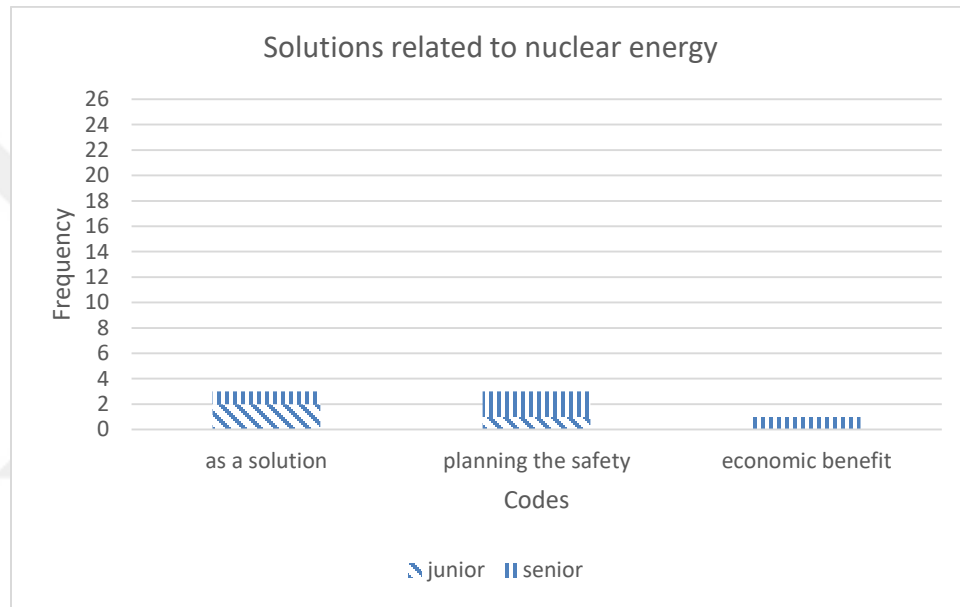


Figure 4.14 Frequencies of codes related to nuclear energy regarding the solutions

The results revealed that the minority of PSTs thought nuclear energy power plants as a solution to the energy-related problems. The reason for this result might stem from their risk perceptions. The majority of the PSTs had risk perceptions about this energy power plant problem and some PSTs were aware of the problems related to the management of these plants. For these reasons, PSTs did not view nuclear energy power plant as a solution to energy demand. Correspondingly, only three PSTs mentioned planning the safety issue. The frequency in this code is small since many of the PSTs did not favor nuclear energy power plants as a solution. Although PST1 in senior year in University A did not support nuclear energy power plants, he suggested

planning the safety as a solution in case any nuclear power plant is constructed. His hometown is close to the construction area of nuclear energy, and he might be more alert about this issue. Therefore, even if he did not favor this plant as a solution, he considered potential precautions and the planning phase of nuclear energy power plant. Furthermore, only this PST mentioned the economic benefit, which is conceptualized as *outcome fairness* in the literature (e.g., Visschers & Siegris, 2012). Outcome fairness is a crucial variable in especially the developed countries since the construction of nuclear energy power plants is based on negotiations with public. It is important to note that only this PST was aware of the fairness of sharing the benefits and costs by considering the local people who live close to the nuclear energy power plants. In terms of the relationships observed in the path analysis, this code might not have a role since many PSTs did not perceive it as a solution to the energy related problems and issues.

4.4.1.2.4 Solutions related to energy conservation

Energy conservation is the easiest and cheapest solution to the energy-related problems (Uqaili & Harijan, 2011). This category refers to the reduction of energy consumption and raising or increasing awareness about energy conservation. Two main codes emerged: (a) reducing consumption and (b) increasing awareness about energy conservation. The frequencies of codes are displayed in Figure 4.15.

The results revealed that half of the PSTs mentioned reducing consumption as a solution. When PSTs mentioned reducing energy consumption, they mostly stated electricity use. Few of them mentioned the use of local foods and reducing the use oil and solutions for reducing the heating at houses. In terms of raising awareness, more than half of the PSTs mentioned increasing awareness about energy conservation as a solution (see Figure 4.15). Having awareness about reducing consumption might help PSTs internalize energy conservation and it lead them display eco-management type

of ECB more. Hereby, the relationship between self-determined motivation and eco-management might be increased.

Table 4.19

Description of codes related to solutions about energy conservation

Codes	Description	Quotation
Reducing consumption	Referring to decrease in energy use through energy conservation, recycling, reusing and consumption of local foods are mentioned.	“For instance, refrigerators with A plus, which consume less energy are available now. LED lamps are also consuming less energy. They all contribute to energy conservation.”
Increasing awareness of energy conservation	Referring to raising awareness of energy conservation or increasing knowledge in the importance of energy conservation through conversations among friends and family, education, renewable energy projects, posters and media.	“I think education is especially important. If people’s awareness is raised, energy saving will be increased in my opinion. I think we should start from there.” (PST5)

Table 4.20

Description the code related to environmentalism

Codes	Description	Quotation
Environmental sustainability approach	Referring to the continued existence of an ecosystem or to an eco-centric value orientation, which reflects concern for earth and nonhuman species.	“[While taking decisions about energy] nature and human centered decisions should be taken rather than economic centered. I think we should consider the future generations in these issues.” (PST3)

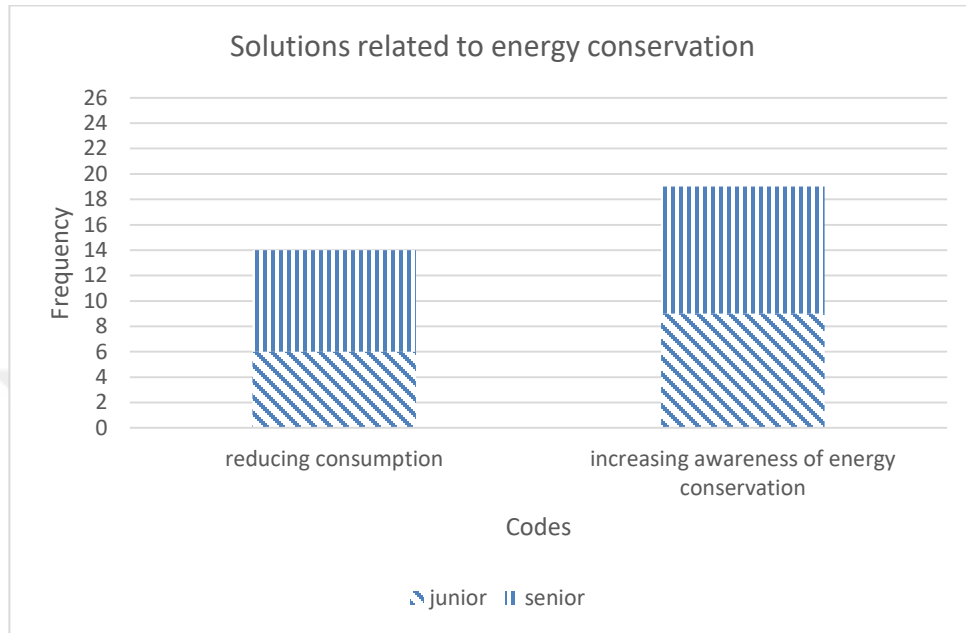


Figure 4.15 Frequencies of codes related to energy conservation regarding the solutions

4.4.1.2.5 Environmentalism

Environmentalism is defined by Zelezny and Schultz (2000) as “the processes associated with actions intended to lessen the impact of human behavior on the natural environment.” (p.367). Participants mentioning this category in the interview argue that the solution to energy problems for a sustainable world is based on the adoption of an environmental worldview.

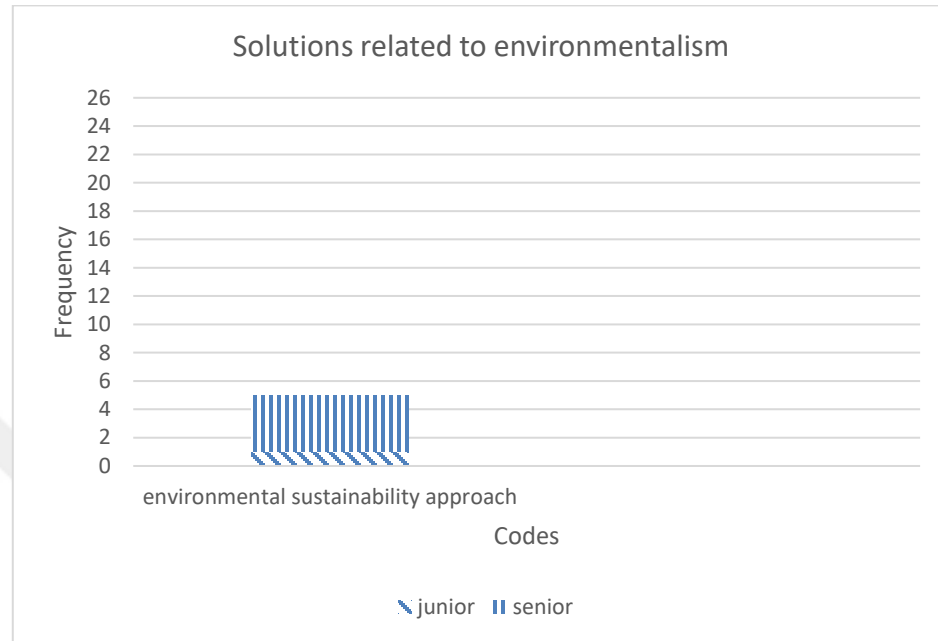


Figure 4.16 Frequency of environmental sustainability approach regarding the universities and grades

The results revealed that a minority of the PSTs mentioned an environmental sustainability approach as a solution to the energy related problems and issues. This solution suggests a macro solution and it shows that these PSTs hold a sustainable view and a holistic approach. The PSTs with this worldview referred to the cases and documentaries in their environmental education courses while they were talking about this solution. Environmental education courses with EE/ESD approach might have had a role in this awareness. Through cases and documentaries, they might have developed a holistic approach to the energy related problems and issues. Through these courses, they might have adopted an environmentalist solution. A junior PST in this university experienced the negative effects of hydroelectric power plant in her hometown. Her hometown is in the middle of nature. Therefore, she developed an environmentalist worldview while growing up in her hometown. However, the majority of the PSTs did

not mention this type of solution. Therefore, this awareness might not have had a role in the relationships in the path model.

4.4.2 The content and instructional features of the courses regarding energy issues

During the analysis, it was observed that the PSTs in University A had high level of awareness, the PSTs in University B had moderate level of awareness and the PSTs in University C had low level of awareness about energy related problems, issues and solutions. This result might stem from their interest in these problems and issues, their personal experience related to them and other factors (e.g., the learning environments). Among these reasons, their environmental education courses might be the source of their awareness. Therefore, the participants were asked what kind of energy-related problems and issues were introduced in their courses. In this way, information about the courses at university level was gathered through the eyes of the PSTs with the interviews on energy-related subjects, teaching methods, and tools (e.g., documentaries) used in the courses. The following part introduced some features through these interviews and syllabi of the courses.

4.4.2.1 University A

In University A, the PSTs at senior level told that the following courses included the energy related problems and issues: (a) Environmental Sciences, (b) Education and Awareness for Sustainability, (c) Climate Change Education for Sustainability and (d) Science, Technology and Society courses. Among those courses, Environmental Sciences and Science, Technology and Society courses are offered as must courses. The rest of the courses are offered as elective courses. All these courses are generally

taken in senior year at this university. When the students were asked to mention what they learned and remembered about those courses, they told that they could not differentiate the environmental education courses (i.e., Environmental Sciences, Education and Awareness for Sustainability, and Climate Change Education for Sustainability) since all these courses are offered by the same lecturer and all these courses are related to each other. Therefore, while these courses are described for University A, Environmental Sciences, Education and Awareness for Sustainability and Climate Change Education for Sustainability courses are all labelled as environmental education courses. However, they do differentiate what they learned in Science, Technology and Society course from the rest of the courses.

4.4.2.1.1 Environmental education courses

According to the interviews with the PSTs and the syllabi in University A, the following topics were introduced in environmental education courses specific to energy-related problems and issues:

- (a) renewable energy resources
- (b) nuclear energy
- (c) the influence of energy generation power plants on environment and society(i.e., hydroelectric power plants and thermic plants)
- (d) sustainability and renewable energy
- (e) global warming and climate change
- (f) climate change in Turkey
- (g) wasteful use of energy
- (h) energy conservation
- (i) solutions and policy including international agreements

According to the information gained from the PSTs, while these subjects were being introduced, the instructor used direct instruction method, questioning, class discussion, case study teaching and field trip methods. Furthermore, the instructor used documentaries, carbon footprint estimation, and some suggested books (i.e., guns, germs and steel) during the course. According to the PSTs, although the instructor did not introduce those topics in relation with energy problems and issues and energy conservation explicitly, s/he implicitly constructed the relationships. Senior PSTs told that they were especially impressed with the cases, carbon footprints and field trips. As an example to the case study, the instructor used a story of a dam in Africa and how animals are affected because of this dam. PST2 mentioned this case as follows:

“It was a documentary related to the impacts of dams. I suppose it was in an African country and the level of water increased so much that even monkeys were about to sink. There was a monkey on a tree and it was about to sink and it was desperate. Animals were transported by helicopters and they were saved in this way. That was very touching for me. I mean the harms caused by the construction of the dam are not one-dimensional. It has multiple impacts on nature, people and animals.” (PST2)

Another case study that the PSTs remembered related to energy topic is the Eymir Lake case, Al Gore’s work with climate change and Seyhan basin. The instructor constructed a real life connection with energy related problems and issues through case studies and documentaries. Furthermore, s/he wanted PSTs to estimate their carbon footprints and they discuss the reasons for increasing footprints and the ways to decrease them. Besides, the PSTs mentioned that the instructor helped them to construct the relationship between climate change and energy use and conservation through carbon footprint activity. In addition to these, the instructor organized field trips. The PSTs told that the instructor organized several field trips within courses. Among them, related to the energy topic, a trip to the integrated solid waste management company was held. The PSTs observed how solid waste is turned into biogas in this plant. The engineers working in this plant informed the PSTs about energy generation from the

waste and how much waste is collected in Ankara and how waste is evaluated in the plant. For example, they not only generated electricity, but they also grew plants through the energy they produced in the plant. These examples provide awareness about the renewable energy of biomass and how much waste is produced in their city.

Table 4.21

Illustrative examples of objectives for Environmental Education courses in University A

Course	Objectives
Environmental Sciences	• Students will learn the Environmental Science is a fascinating combination of science, economics, politics and morals. • Students will learn sustainable development as a solution for environmental threats. • Students will make connections between economy, society and environment.
Education and Awareness for Sustainability	• Students will understand that they are part of the natural circle. • Students will gain an awareness of and sensitivity to the whole environment.
Climate Change Education for Sustainability	• Students will learn the key concepts related to climate change • Students will develop attitudes toward and awareness of climate change-related threats. • Students will develop climate literacy.

These findings revealed that the instructor enriches the courses with various tools and attracts the attention of PSTs about the energy related problems and issues. Furthermore, it is understood that the instructor integrated the environment, society and economy dimensions of energy issues into the course through the cases, documentaries and field trips. Based on all these evidence, the environmental courses in this university were taught through environmental education and sustainability approach (EE/ESD). Furthermore, the objectives of the environmental education courses in the syllabi

support these approaches. That is, in addition to improving scientific knowledge related to environmental science and sustainability, the objectives are promoting awareness of local and global environmental problems and issues, realizing the relation of these problems and issues with daily life and sustainability, and developing environmentally-friendly behaviors. Table 4.21 shows examples for these objectives.

The analysis showed that the PSTs in this university were aware of many problems and issues related to energy. On the other hand, the junior PSTs have not taken those courses. Except for two PSTs, the rest of them were not aware as much as the seniors. Two PSTs who were aware of the problems and issues experienced these problems in their hometowns due to the hydroelectric power plants. Therefore, they may be sensitive to the energy related problems and issues. Based on all these results, it may be concluded that these courses might contribute to PSTs' awareness through real life connections provided in the courses.

4.4.2.1.2 Science Technology and Society Course

As mentioned above, this course is a must course in University A, which is offered to senior PSTs. According to the interviews with PSTs, the following subjects related to energy problems and issues were introduced in the course:

- (a) Nuclear energy power plants as a socio-scientific issue
- (b) The impacts of renewable energy resources (i.e., hydroelectric power plants, wind power plants and fossil fuels) on environment and society
- (c) Global warming and climate change

The PSTs told that these energy-related issues are covered with argumentation teaching method during the course. These subjects were investigated as socio scientific issues. Most of the time, stakeholders about the issue (e.g., politicians, local people, scientists, economists, etc.) were constituted as proponents and opponents, and the PSTs

discussed the issue considering their role and positions. While they were discussing the issues, the instructor led them to use scientific data, reports and technology. The PSTs told that they learned how to discuss an issue in this course, and all the discussions were productive and provided a supportive learning environment for them. As an example, PST4 told that:

“We learned that instead of insisting on an idea, listening to the ideas of the opponents and making an evaluation is the best. These courses, especially the STS course, contributed to me a lot regarding the use of argumentation and knowledge related to energy resources”

This course mainly focused on PSTs’ argumentation and its support while using energy related issues as tools. The syllabus of this course supports this claim. Table 4.22 presents some examples of the objectives.

Table 4.22

Illustrative examples of objectives for Science, Technology and Society course in University A

Objectives
• PSTs are able to define the interaction among science, technology and society. • PSTs are able to utilize argumentation skills (claim, justification and rebuttal) in making decisions on socio-scientific issues.

This course can be a source for PSTs about the awareness of energy related problems and issues. By discussing the issues through the eyes of several stakeholders, they may be aware of the multi-dimensional nature of these issues (e.g., environment, economy, policy). This course might also provide a real life connection to PSTs and they might increase their knowledge and awareness in this course.

4.4.2.2 University B

In University B, the PSTs told that energy related issues were mainly included in the Environmental Sciences and Methods of Teaching Science-I and II courses. In addition to these courses, Special Topics in Biology, Chemistry and Physics courses had some points about energy resources, but the students did not remember many things about these courses. Therefore, Environmental Sciences and Methods of Teaching Science-I and II courses are described below taking the interviews with the PSTs and the syllabi into account.

4.4.2.2.1 Environmental Science course

This course is offered as an elective course to the PSTs in University B. All PSTs in University B had already taken this course. They told that they had taken this course in their third year. Although the subjects that were taught were similar, the lecturer did not include the field trips in the course program. Therefore, the juniors did not have field trips, but the seniors had the experience of the field trips.

According to the interviews and the syllabus of this course, the subjects related to energy were:

- (a) energy resources
- (b) energy conservation
- (c) global warming
- (d) Agenda 21 and international agreements

According to the interviews with the PSTs, the instructor had a topic list which included environmental problems and the PSTs were asked to create groups. Each group selected a topic and prepared their presentations with the instructor's guidance. The subjects

related to energy introduced above were included in the presentations. In this course, the PSTs calculated their carbon footprint and discussed in the class how to decrease them. In this way, they learned how consuming energy causes an increase in their carbon footprint and how energy conservation helps them to decrease it. Furthermore, one of the groups went to a bus station in order to investigate how much distance is taken on average by bus companies in a day, how many people are carried in a day, how much waste is produced and how much of the waste is recycled. One of the PSTs in this study was in this group and she told she was surprised that only one bus company recycled the waste. She told:

“Our instructor wanted our group to investigate how many times a bus company makes a round in a day, how much garbage they produce, how many kilometers they make in one day, and how many people they carry in one day. Most importantly, do they create separate garbage for recycling? Our research showed that only one bus company recycled materials. That is, they used separate garbage boxes for plastic, cardboard, and so on... We saw that there is a lot of carbon emission. Maybe we visited 100 companies, and we only found one company which recycled. We saw how much damage people cause to the environment. We spend a lot of energy. On average, one company made 30 rounds in a day. If we think that they carry 45 people in each round, tons of garbage is produced each day. I really understand that we have a serious impact on the environment.” (PST17)

This homework raised an awareness about energy waste and the importance of energy conservation through recycling. In addition to this, the instructor wanted the PSTs to learn how to repair a faucet as a way to learn water conservation. The PSTs in the interviews also formed a link between water conservation and energy conservation. As an example, PST16 told that:

“Energy is required in order to use water in our houses because a pumping system, which works with electricity, is used for that. Therefore, all are related with each other, and we need to conserve water for energy conservation.” (PST16)

In this course, as an instructional method, presentations were mostly used. The activities, such as carbon footprint, related to energy were involved in the course. In addition to this, field trips were organized to the zero-energy building and energy park in the General Directorate of Mineral Research and Exploration. The PSTs also participated in a seminar regarding energy resources in these field trips. This course provided students with some opportunities for raising awareness about energy related problems and issues. Furthermore, it is understood from the interviews that the instructor adopts an environmental education approach in this course. The syllabus of the course supports this claim. Table 4.23 shows a section from the syllabus.

Table 4.23

Illustrative examples of objectives for Environmental Science course in University B

Objectives
• Students will be aware of the relationship between biotic and abiotic factors. • Students will be able to transfer environmental causes of the problem and the solution to their daily life • Students will design activities, which aim to raise awareness and improve behavior.

4.4.2.2.2 Methods of Teaching Science I and II courses

The Methods of Teaching Science-I is offered to the juniors, and the Methods of Teaching Science-II is offered to the seniors. According to the interviews, Methods of Teaching Science-I includes the following subjects related to energy:

- (a) Nuclear energy as an issue
- (b) The introduction of “*educational project of Yesil Kutu*”, which includes lesson plans and activities related to energy conservation

According to the information obtained from the interviews, Methods of Teaching Science-II includes the following subjects related to energy:

- (a) Nuclear energy as an issue
- (b) Climate change
- (c) Illegal energy use
- (d) The impacts of use of fossil fuels

The issue of nuclear energy power plants was covered with argumentation method in these two courses. The junior PSTs told that the argumentation was not productive for them since the class was very crowded and their friends insisted on their argument without listening to the opposing views. PST16 mentioned this issue as follows:

“In the Instructional Method course, nuclear energy topic was used for argumentation method, but the class was distracted and conflict among groups was created. Therefore, we could not continue the argumentation. Besides, the class was very crowded. The population in our class is generally around 60. Therefore, we had problems in argumentation. In addition, we could not understand very much what to do in this method and we did not know how to discuss this topic. Our friends insisted on their view and they just did not allow the others to defend their ideas. Actually, the nuclear energy topic is very interesting and very suitable for argumentation method, but we just could not handle it during the course.” (PS17)

This issue is also covered in the Methods of Teaching Science-II course and PS11 told that the course contributed to his knowledge about nuclear energy since they worked on the issue at least for two weeks and discussed it in the class. PST11 told that:

“In Methods of Teaching Science-II course, we did research on nuclear energy power plant and discussed it in class. This topic was covered for two weeks and the argumentation method was used. When this kind of topics are discussed with classmates, they are more effective and permanent... Thanks to this course, I learned many things about nuclear energy.” (PST11)

Furthermore, in the Methods of Teaching Science-I course, “*educational project of Yesil Kutu*”, which is a course support material that can easily be used for raising awareness about environmental issues and energy conservation, promoting positive

environmental attitudes and behaviors, was introduced to the PSTs in a seminar in this university. Following this seminar, they prepared an assignment, which aimed to make the PSTs familiar with this material. In this material, energy conservation is included and lesson plans and activities are suggested within the box. The PSTs told that they got an idea about how to raise awareness about environmental issues in their professional life in the future. For example, PST15 told that:

“In Methods of Teaching Science course, a volunteer from green box (*Yesil Kutu*) came and introduced this educational set to us. They distributed a CD of it. Various environmental problems, energy problems and social problems were mentioned....I learned that it is a useful tool for raising awareness about these problems...I remembered that there were two or three lesson plans for energy conservation and I examined them for my project related to energy conservation. It leads students to prepare a poster for energy conservation or it suggests some activities to teachers” (PS15)

4.4.2.3 University C

In University C, the PSTs told that they did not remember many things about whether the courses they have taken included energy related problems and issues. Therefore, the syllabus of Environmental Sciences course was examined regarding the objectives. The objectives of this course are based on only knowledge domain (e.g., Students are able to define biotic and abiotic environments; Students will be able to differentiate matter cycles). Objectives and skills related to environmental education were not involved. That is, environmental education approach or sustainability approach was not adapted for this course. That might be a reason for the low awareness about energy related problems, issues and solutions in this university. In addition to this, PSTs' lack of personal experiences, their low interest in this topic and their social environment might be the reasons for their low awareness.

CHAPTER 5

DISCUSSION

The modern lifestyle is highly dependent on energy so that civilization of humankind can continue (Dias et al., 2004). However, the primary energy resource is still fossil fuels and generating energy from this energy resource is a barrier for climate change mitigation (Foster, Contestabile, Blazquez, Manzano, Workman & Shah, 2017; Hinrichs & Kleinbach, 2013; Titenberg & Lewis, 2015). There are several strategies for climate change mitigation. These strategies are energy conservation by behavior change and efficient energy use, using renewable energy resources, reducing population growth, decelerating economic growth, carbon capture and storage method, and geo-engineering (Nibleus & Lundin, 2010). Among those methods, energy conservation is the cheapest and easiest way (Dias et al., 2004). Therefore, investigating variables explaining this behavior is critically important for climate change mitigation. In this regard, two major research interests are explored in this study. One of them is exploring the pre-service science teachers' (PSTs) energy conservation behavior (ECB) through affective variables (i.e., attitudes toward energy conservation, basic psychological needs and motivation toward energy conservation). The other focus is the exploration of the role of awareness of PSTs in the relationships between affective variables and ECB mentioned in the first interest. Through ECB, household energy conservation is considered in this study.

This chapter starts with the interpretation and discussion of descriptive results and findings in the proposed path model by considering the results of the qualitative data and the studies in the literature. Next, awareness of the PSTs was discussed.

Then, implications for educational policy are presented. Lastly, recommendations for further research studies are introduced.

5.1 Energy conservation behavior of preservice science teachers

In order to explain energy conservation behavior (ECB) of preservice science teachers (PSTs), a path model was proposed. Two types of ECB emerged (i.e., eco-management and persuasion types). The PSTs scored higher on eco-management type of ECB than persuasion type. There may be three underlying reasons. First, the PSTs might find it easier to display eco-management type ECB. Second, they might have low self-efficacy in communication with the society they live in. Thirdly, most of the pre-service teachers in Turkey have low socio-economic status (Aksu, Demir, Daloglu, Yildirim & Kiraz, 2010; Bahar, 2002; Orhan-Eret & Ok, 2014; Saban, 2003). The study of Martinsson et al. (2011) showed that people with low socio-economic status save more energy than those with high socio-economic status. Therefore, the PSTs in this present study might perform eco-management type of ECB due to economic reasons. However, Martinsson et al. (2011) also found that besides socio-economic status, affective variables had a crucial role in ECB. The study of Steg (2008) also highlighted the important role of affective variables in ECB. Studies exemplifying these claims are discussed below.

Sahin (2013), who studied in Turkish context, found a lower score for ECB when compared with this present study. The behavior items in that study were similar to the eco-management type. In the study of Sahin (2013), the sample size was smaller and it covered not only PSTs but also pre-service teachers from other departments. On the other hand, the sample in this current study covers only PSTs and due to their major, they might have more knowledge and awareness about energy conservation. The score of autonomy/competence need was also found higher for PSTs, which indicates that they had high self-efficacy for energy conservation. In other words, they perceived that they had knowledge and competence for energy

conservation. Sahin (2013) also thought that the sample in her study might not be aware of energy conservation ways.

In terms of persuasion behavior, the study of Boubonari et al. (2013) shed light on the discussion of this result. Bouboari explored Greek pre-service teachers' environmental behavior toward marine pollution. Although the behavior context is different from this current study, two studies explored specific context within pro environmental behavior. The study of Boubari found that the participants displayed more individual behavior than collective action behavior. Individual behavior corresponds to physical or eco-management behaviors and consumer behaviors. Collective action is somewhat similar to persuasion, legal and political type of behaviors. The authors of that study explained the difference regarding the cultural context. That is, eco-management type of behaviors is supported by educational system of Greece and the media. Besides, eco-management type of energy conservation is accepted as easier to display and it brings financial benefit to the behavior owner (Goldman et al, 2006, as cited in Bouboari et al., 2013). In a similar vein, the participants in this current study might feel more comfortable in eco-management type of ECB since displaying this type of behavior might be easier than persuasion behavior. Another reason might stem from the participants' low self-efficacy in communication with society they live in, and they might hesitate to persuade others to conserve energy. This result might have resulted from awareness of the PSTs regarding energy related problems, issues and solutions. Their awareness of dependence on foreign energy resources, limited use of renewable energy and wasteful use of energy was considerably high and this awareness might contribute to their eco-management type of energy conservation. There are many studies in the literature supporting the relationship between environmental awareness and environmentally friendly behavior (e.g., Dal et al., 2015; Nordlund & Garvill, 2003; Steg & Vlek, 2009; Zhu, 2016; Zsoka et al., 2013). However, the awareness of PSTs regarding problems related to energy policies and implications, the impacts of various energy resources and the relationship between energy use/production/conservation and climate change was very low. Lack of awareness

in these specific types of awareness might explain why PSTs were uncomfortable with the persuasion type of ECB.

5.2 Discussion of the relationships in the path model

The estimated goodness-of-fit indices showed that the model fits the data well. It means that the path model, which was specified for investigating the relationships, is valid for interpretations. While interpreting the results, the values of standardized path coefficient are taken into consideration as suggested by Kline (2011). Moreover, this value is used for interpreting the strength of the relationships in the model (Pedhazur, 1997). In the path analysis, the direct relationships with ECB were investigated. It is known from the literature that the exogenous variables are associated (e.g., Wilson et al., 2003; Ryan & Deci, 2017). The estimations also supported this claim. Therefore, covariances were put among exogenous variables. Putting the covariances among exogenous variables mean that there are correlations among these variables, but they are not analyzed for the purpose of predictions or interpretations (Kline, 2011). Correspondingly, the interpretations of correlations among these variables are out of the focus of this study.

The analysis showed that the proposed path model explained 30% of variance in the eco-management type of energy conservation behavior and 25% of variance in the persuasion type of energy conservation behavior. This result indicated that the path model significantly predicted considerable amount of the variance in energy conservation behavior (ECB) of pre-service science teachers (PSTs). When compared with the studies of Abrahamse and Steg (2011) and Ibtissem (2010), which used TPB and VBN theories, the explained variance in ECB was larger in this study. That is, the study of Abrahamse and Steg (2011) explained 15% of variance in ECB with the VBN theory, and 5% of variance was explained with the TPB theory. The participants were 199 households in the Netherlands and the average age was 47. Likewise, the study of Ibtissem (2010), conducted with 703

people in Tunisia, found that the VBN theory explained 5.8% of variance in ECB. On the contrary, the explained variance in the study of Sahin (2013), which used the VBN theory and which was conducted with 512 pre service teachers in Turkey, showed a similarity with this study. That is, 28% of variance in ECB was explained. By considering all these results together, it can be concluded that SDT is as strong as VBN and TPB theories in predicting ECB.

There are also studies with SDT exploring ECB. For example, the study of Webb et al. (2013) examined ECB with 200 people who were between 18 and 70 years old. The study used SDT in order to predict ECB, and a model was proposed for this purpose. The goodness-of fit indices were good enough to draw conclusions. The results revealed that 23% of variance in ECB was explained with the model. Parallel to this study, Cheung et al. (2016) investigated ECB with SDT and goal-directed behavior. By adopting these two theories together, a model was proposed for 1004 people between 18 and 70, and the results showed good-fit-indices. The model explained 27% of variance in ECB. The explained percentage in ECB with SDT studies showed a similarity. By considering all these studies, it can be concluded that SDT is successful in explaining ECB. That is, how people are motivated for energy conservation and their psychological needs for this behavior are important for shaping their behavior.

5.2.1 Relationship between attitude toward energy conservation and energy conservation behavior

The PSTs in this study had moderately strong attitude toward energy conservation. This finding of the current study is consistent with the studies which revealed a strong attitude toward energy conservation (e.g., Abrahamse & Steg, 2009; Martinsson et al., 2011; Sahin, 2013). This result might be explained with three reasons: (1) educational level, (2) age of participants and (3) environmental education related courses. Some studies (e.g., Mills & Schleich, 2012; Torgler & Garcí'a-Valinas, 2007) showed that people with high levels of education had more

positive attitude toward energy conservation than people with low levels of education. Likewise, age of participants may have a role in their attitude. That is, young to middle age people had more positive attitude toward energy conservation (Mills & Schleich, 2012). Due to education level of PSTs and their age, they might have a strong attitude toward energy conservation. The study of Barata, Castro and Martins-Loução (2016) provides evidence for the third reasoning. Their study showed that participants who took environmental education course had significantly more attitudes toward energy conservation than the participants who did not take any environmental education course. According to the context of the courses suggested by the Council of Higher Education of Turkey, environmental sciences course is offered in the science teacher education program. This course might contribute to PSTs' moderately strong attitude toward energy conservation.

Concerning the relationship between attitude toward energy conservation and energy conservation behavior (ECB), it was hypothesized that attitude was positively linked to PSTs' ECB. As expected, this relationship was found as positively significant. Specifically, the relationship between attitudes and eco-management type of ECB was found as positively significant and weak. This result is consistent with the study of Boubonari et al. (2013), who classified environmental behavior as individual action and collective action behavior. The items in individual action are parallel with the eco-management behavior, and the items in collective action are similar to the persuasion behavior. In a similar vein,, Boubonari et al. (2013) found a weak correlation between attitude and individual action of pre service teachers, and between attitude and collective action regarding pro-environmental behavior. However, regarding the strength of the relationship between attitude and pro-environmental behaviors, the literature shows a great deal of variation. Similar to this study, some studies found weak correlation between attitudes toward energy conservation and ECB (e.g., Abrahamse & Steg, 2009), whereas some studies found a medium correlation (e.g., Nagev et al., 2008). The weak relationship may stem from the external factors such as the cultural features of countries (Kollmus & Agyeman, 2002).

5.2.2 Relationship between basic psychological needs and energy conservation behavior

The exploratory factor analysis conducted for basic psychological needs for energy conservation (BPNEC) instrument showed that it is two dimensional (i.e., autonomy/competence and relatedness). This result was confirmed with confirmatory factor analysis. The two dimensional structure is consistent with the study of Sweeney et al. (2014), who adapted the instrument to the energy conservation context. Self-determined motivation theory (SDT) claims that without the satisfaction of competence need, autonomy would not be realized. In other words, for the feeling of autonomy in a behavior, one should feel that s/he has the necessary skills and information for the behavior. Theoretically, the sense of competence is a pre-requirement for autonomy (Ryan & Deci, 2000a; Ryan & Deci, 2017). Therefore, the result of merging of these two dimensions is acceptable.

Mean scores were calculated on a seven point Likert type for two dimensions of BPNEC. PSTs' scores on autonomy/competence and relatedness needs for energy conservation were moderately high. That is, the PSTs felt self-confident about energy conservation, and they felt that this behavior originated from inner forces such as willingness. Furthermore, they felt attached to the society they live in in terms of energy conservation. These results might be explained with the courses taken by the PSTs. Some courses (e.g., Environmental sciences) support their autonomy, competence and relatedness needs. The studies indicate that EE and ESD approach courses promote basic psychological needs of learners (e.g., Darner, 2012; Karaarslan et al., 2014; Karpudedewan et al., 2017). In addition to this, their family might have a role in this result. If their family give importance to energy conservation and reinforce their behavior, their sense of relatedness and competence are supported.

In terms of the relationships between the dimensions of basic psychological needs and ECB, the studies showed that these two variables are associated (Cooke et al.,

2016; Sweeney et al., 2014). For instance, Sweeney et al. (2014) found that the relationship between autonomy/competence and ECB was greater than the relationship between relatedness and ECB. This result is similar to the results of this study in that the relationship between autonomy/competence and eco-management type of ECB was significantly positive and at low level, and the relationship between relatedness and eco-management type of ECB was insignificant. However, the relationship between relatedness and persuasion behavior was different. A positively significant and low level of relationship was found. On the other hand, the relationship between relatedness and eco-management behavior was insignificant. In conclusion, the type of ECB is important regarding the strength of the relationship with basic psychological needs. However, the number of studies differentiating the types of ECB and investigating this relationship is very limited.

5.2.3 Relationship between motivation toward energy conservation and energy conservation behavior

Motivation toward environment scale was adapted to energy conservation by the researcher for this study, and expert opinions were received. Exploratory factor analysis was performed to figure out the factor structure of the instrument. Four factors (i.e., self-determined motivation, introjected regulation, external regulation, amotivation) were explored. Then, four factorial structure was confirmed with confirmatory factor analysis. This factor structure does not contradict with SDT since a continuum basis is described and the merged factors (i.e., intrinsic motivation, identified regulation, integrated regulation) are the self-determined types of motivations. Besides, this factor structure was supported by Standage et al. (2003) in physical education context. Although the context in this study is different, a similar factor structure can be observed among various disciplines.

The highest mean score was obtained from self-determined motivation, and the lowest score was found in amotivation. It means that the PSTs displayed ECB since

they may have felt pleasure, internalized this behavior into their lives or considered it as personally important and sensible. The low score in amotivation means that the PSTs had sense of helplessness concerning energy conservation behavior.

Concerning the relationship between motivation types and ECB, the results showed a variation regarding the types of ECB. A moderate relationship between self-determined motivation and eco-management was found. On the contrary, a weak correlation was observed between self-determined motivation and persuasion. Although the majority of the PSTs were not aware of many dimensions (e.g., policy, impacts of energy resources) of energy-related problems and issues, the majority were aware of the problems related to energy conservation (i.e., wasteful use and unawareness of energy conservation). This awareness may explain the higher correlation between self-determined motivation and eco-management type of ECB. Furthermore, awareness of problems related to energy conservation might help the PSTs internalize eco-management behavior. This argument is supported by Ryan and Deci (2017). Correspondingly, awareness may assist basic psychological needs, and in this way, people may internalize certain behaviors. In a similar vein, some studies support this moderate strength relationship (e.g., Pelletier et al., 1998). Furthermore, the strength of this relationship is also dependent on the sample from which the data is collected. For instance, Cooke et al. (2012) investigated the relationship between self-determined motivation and pro-environmental behavior with environmentally active people. The items in easy pro-environmental behavior are mainly related with eco-management type of household ECB. Therefore, the results can be compared with the current study. The strength of the correlation between self-determined motivation and easy pro-environmental behavior was greater than the finding of this study. The reason might be related to the sample. That is, the relationship between these variables might be stronger in environmentally active people. Furthermore, the researchers also found a higher correlation with difficult environmental behavior, which includes policy, persuasion and consumer type of ECB items. The study of Cheung et al. (2016) also provides evidence regarding the role of sample. This study was conducted with 1004 people in Hong Kong. It showed a lower strength regarding the relationship

between self-determined motivation and ECB. The sample in the study of Cheung et al. (2016) covers a variety of people in terms of age.

Interestingly, the relationship between self-determined motivation and persuasion type of ECB was weak. However, the relationship between self-determined motivation and eco-management was found to be stronger. There is a paucity of literature regarding the relationship between persuasion behavior and motivation types. However, the qualitative data of this study may shed light on the reasons for the weak correlation between self-determined motivation and persuasion. This result may spring from their unawareness about multi-dimensional feature of the energy related problems and issues. That is, even if they have self-determined motivation for energy conservation, due to the lack of awareness of the multiple dimensions of energy related problems and issues, they might hesitate to persuade people to conserve energy.

The relationship of introjected regulation with eco-management and persuasion was found to be positive and weak. Similarly, weak and positive relationships were explored between introjected regulation and pro-environmental behaviors (e.g., Pelletier et al., 1998; De Groot & Steg, 2010). People with introjected regulation generally display the behavior to avoid diminishing self-esteem. Since the behavior is not internalized into one's own completely, the strength of the relationship between this motivation type and behavior is weak. This type of regulation is the most primitive form of internalization; hence, the behavior is still regulated by external forces.

A negative relationship was proposed between external regulation and eco-management, and a negative and weak correlation was found in the analysis. In a similar vein, either negative or insignificant relationship was found in the literature (e.g., Pelletier et al., 1998; De Groot & Steg, 2010). However, a positive relationship was observed between external regulation and persuasion behavior in the model. It means that when PSTs are motivated externally, they are unlikely to perform eco-management behaviors, but they might perform persuasion behavior. It is important to note that this relationship was found as weak. However, the study

of Cheung et al. (2016) found a negative and weak correlation between extrinsic regulation and ECB. This result is an unexpected result. One of the possible reasons for this result might be related to the educational system in Turkey, which is mainly based on national examination and high levels of competition (Kingir, Tas, Gok & Sungur Vural, 2013). The paper-pencil examination system with multiple choice type questions might reinforce external motivation. The PSTs who participated in this study experienced this examination system as well. This experience might be a part of their culture and this culture might be a reason for the positive relationship between external regulation and persuasion behavior. Lastly, a negative relationship was proposed between ECB types and amotivation. These paths were found as insignificant. This result was supported with other studies in the pro-environmental behavior context (e.g., Cheung et al., 2016; Pelletier et al., 1998).

5.3 Awareness of PSTs and the role of courses for raising awareness

The findings of qualitative data revealed that the awareness of the PSTs exhibited substantial variation in terms of the content and teaching approaches they experienced regarding the energy related problems and issues. One of the universities in qualitative part (Univ.A) offered more than one environmental education course and offered Science, Technology and Society (STS) course. The awareness of the PSTs taking those courses was higher when compared with other PSTs. Therefore, the association between the teaching methods and approaches and awareness of the PSTs were discussed below by considering the courses, which involved energy related problems and issues based on the interviews with the PSTs in this university and the syllabi of these courses.

Environmental education courses were taught with environmental education (EE)/education for sustainable development (ESD) approach in this university according to the objectives in the syllabus. The instructor used a wide variety of teaching methods during the instruction of energy related topics, such as field trips, case study, discussion and direct instruction. Furthermore, documentaries and

carbon footprint were used as tools with these teaching methods. Through these teaching methods and tools, s/he exemplified the energy related problems and issues such as the effect of climate change and hydroelectric power plants. Furthermore, these methods and tools may be helpful to exemplify the multiple perspectives of energy related problems, issues and solutions. In conclusion, the use of field trips and cases with documentaries and carbon footprint may contribute to PSTs' high level of awareness of energy related problems, issues and solutions. This conclusion is consistent with the study of Schmidt and Cogan (2014), who explored the effect of field trip within a course. The study was conducted with science teachers. The participants were taken to an energy park, which focused on awareness of energy topic. The results showed that their awareness about this topic increased with this course. Parallel to this study, Karpudewan and Mohd Ali Khan (2017) explored the awareness of sixteen-year-old secondary school students regarding climate change topic. Students took a field trip to gain more awareness about climate change. Supported by the empirical study of Tortop and Ozek (2013), the study was conducted with secondary level students, who took a field trip to a renewable energy research and implementation center. At the end of the field trip, these students developed a higher level of awareness about sun power and its use. Furthermore, Dillion et al. (2006) emphasized that students remember what they learned from field trips for a long time. Therefore, awareness acquired through field trips can last longer. Concerning the effect of documentaries, the study of Lambert and Bleicher (2013) with preservice teachers found that the use of documentaries with inquiry based teaching methods helps PSTs increase their awareness of climate change. Parallel to this result, the instructor of environmental education courses used some documentaries to support his/her teaching. These documentaries may contribute to PSTs' awareness. Besides, the instructor used carbon footprint activity to raise the awareness of the PSTs about their energy use, and to show how to conserve energy in their daily life. This activity is commonly advised in the literature in order to promote energy conservation and as a way of contribution to climate change mitigation (Karpudewan & Mohd Ali Khan, 2017; Miler et al., 2012). Another distinct method used with the EE/ESD approach regarding energy

topic was case study teaching. In this method, real life stories are used (Herreid, 2007, 2011). Through the story of cases, real life connection is built and awareness of learners about environmental issues can be raised (Erdogan & Tuncer, 2009). Several studies showed that this method is successful for increasing awareness of college students and secondary level students (e.g., Erdogan & Tuncer, 2009; Samsudin & Harun, 2017; Oliver, 2006). This teaching method might also contribute to the awareness of PSTs.

Besides environmental education courses with the EE/ESD approach, the PSTs having high level of awareness took the STS course. This course used argumentation-teaching method for some issues related to energy (e.g., construction of nuclear energy power plant, hydroelectric power plant and wind power). PSTs discussed the issues from a multiple perspective of stakeholders. This method was found to be successful for raising awareness about energy related problems, issues and solutions (e.g., Jho et al., 2014; Lambert & Bleicher, 2012). Based on these evidences from the literature, the high level of awareness of PSTs may be attributed to these environmental education courses with the EE/ESD approach and the argument-driven Science, Technology and Society course.

In addition to the courses, life experiences may have a role in this awareness. Among the participants, two PSTs, who were juniors and who have not taken any environmental education courses yet, experienced the impacts of several energy resources in their hometown (e.g., hydroelectric power plant, thermic plant, wind power). Studies emphasized that life experience contributes to awareness significantly (Chawla, 1998; Korhonen & Lappalainen, 2004; Petegem et al., 2007; Rajecki, 1982; Tanner, 1980). Similarly, these PSTs had awareness to some degree (i.e., their awareness is high regarding the impacts of energy resources and energy conservation). However, their awareness was low regarding problems related to energy policies and implications, understanding of global warming, and solutions related to energy policies and implications compared with the senior students. Correspondingly, the current study showed that first-hand experiences regarding energy problems and issues contributed to the awareness about impacts of energy

resources, energy conservation, and solutions related to energy resources and conservation. However, life experiences may not be enough to hold multiple perspectives on this issue. The value of education with a contemporary approach (e.g., use of various teaching methods, documentaries) is critically important in this regard.

PSTs' understanding of global warming is also a component within awareness. Some of the PSTs were aware of the relationship between energy use/production/conservation and global warming. The majority of them took more than one environmental education course with the EE/ESD approach and the STS course. On the other hand, the majority of the participants had misconceptions about this relationship. As an example, some PSTs thought that air pollution or ozone depletion causes global warming. This misunderstanding was common in many studies (e.g., Choi et al., 2010; Liarakau et al., 2011). Another example is that few PSTs thought that nuclear energy power plants or accidents in nuclear energy power plants cause global warming. A similar result was obtained in the study of Ocal, Kisoglu, Alas and Gurbuz (2011), which was conducted with Turkish elementary pre-service teachers. This result may have stemmed from the visuals of nuclear energy power plants in media (Ocal et al., 2011).

Marcinkowski (2009) claims in his review that EE programs should be well prepared and delivered considering the content and pedagogy carefully. In that way, professional development of preservice and in service teachers is supported. Parallel to this claim, integrating the EE/ESD approaches into energy topic might contribute to PSTs' awareness of energy related problems, issues and solutions. Indeed, the aims of the EE/ESD approach involve enhancing the learners' affective, motivational, dispositional and environmentally friendly behaviors (UNESCO, 2017).

Concerning SDT, basic psychology of PSTs regarding energy conservation should be integrated into the environmental education courses. The study of Darner (2009) and Karaarslan et al. (2014) indicated that when the needs of autonomy, competence and relatedness of learners were satisfied in environmental education courses with

the EE/ESD approach, their self-determined motivation was promoted for environmental behavior. In a similar vein, in order to develop self-determined motivation for energy conservation behavior of PSTs, their autonomy, competence and relatedness needs for energy conservation should be satisfied. To do this, carbon footprint activity may be helpful. When PSTs are aware of how to reduce their carbon footprints, their competence needs are supported. Documentaries showing the efforts of scientists, engineers and public for energy conservation may help increase PSTs' relatedness feeling. Assigning projects for decreasing energy carbon footprints might be useful for increasing relatedness feeling among the classmates of PSTs. In addition to this, this type of assignments, which enable PSTs to investigate the issue by having discussions with classmates, may promote their autonomy needs. Rather than dictating them to conserve energy, helping them to gain awareness of multi-dimensional structure of energy related problems and issues may lead them to conserve energy willingly. In this manner, their autonomy need may be satisfied. In addition to this, introducing the environmental and social effects of energy generation power plants through cases, documentaries and argumentation methods may increase PSTs awareness of energy related problems and issues. Through these methods, they may figure out the importance of energy conservation and they may internalize this behavior. In this way, they may conserve more energy in order to contribute to climate change mitigation. Furthermore, various energy policies of countries, which support the sustainability of environment, should be introduced to them through documentaries or cases. Hereby, their awareness related to policy dimensions may be increased and it may help them understand that energy related problems and issues are complex, and they influence many stakeholders such as public, scientists, economists and policy makers. This awareness may help PSTs internalize energy conservation, and through this internalization, they may increase their eco-management behavior and persuasion behavior. All these exemplified teaching methods and tools can support the EE/ESD approach as well. From this point, ESD and EE/ESD approach are complementary to each other as far as promoting energy conservation behavior is concerned.

It is important to note here that this study is not an experimental study. Therefore, a causal relationship is not constructed between awareness and the courses the PSTs have taken. There may be other reasons (e.g., socio-economic factors, personal interests in these problems and issues, childhood) for the differences in the awareness level of the PSTs among universities.

5.4 Conclusions

- As one of the significance of this study, the basic psychological needs for energy conservation scale was adapted to Turkish, and the motivation toward environment scale was modified to energy conservation context and was adapted to Turkish. Further studies adapting self-determination theory (SDT) within energy conservation context can be conducted by using these instruments.
- This study provided evidence about energy conservation behavior (ECB) of pre-service science teachers (PSTs), their attitudes, motivation and basic psychological needs for energy conservation. Furthermore, the direct relationship between these variables and ECB was explored. The highest correlation was found between self-determined motivation and eco-management type of ECB. It is concluded that to support eco-management type of ECB, PSTs' self-determined motivation should be supported. However, the relationship between self-determined motivation and persuasion type of ECB was not high. A possible explanation for this finding might be related to their awareness. The qualitative data showed that PSTs' level of awareness of energy related problems and issues regarding multiple dimensions (e.g., policy, society and environment) was low. This low level of awareness might be a reason for the weak relationship between self-determined motivation and persuasion behavior.

- The path between relatedness and eco-management type of ECB was found as insignificant. There may be an indirect relationship between these two variables and self-determined motivation might mediate the relationship between these two variables. On the other hand, the relationship between relatedness and persuasion was found as significant and relatively high. When PSTs feel that their society give importance to energy conservation and they feel attached to the society, they display more persuasion type of ECB. It may be concluded that in order to increase their persuasion behavior, their relatedness need should be satisfied.
- Although a negative path had been proposed between external regulation and persuasion, a positive relationship was found. It is concluded that even if PSTs hold external regulation for energy conservation, they display persuasion behavior for energy conservation. It may be a reflection of the educational settings of Turkey, which promote external regulation among students through paper pencil assessment in a highly competitive environment. PSTs also have to take a national competitive examination for being a teacher after their graduation. This competitive environment may have a role in this unexpected result.
- The qualitative data showed that the level of awareness of the majority of PSTs was relatively high in problems related to energy conservation. In terms of problems related to energy policies and implications and energy resources, their awareness showed a variation from high to low. Therefore, it may be concluded that the majority of PSTs were not aware of the multiple dimensions of energy related problems and issues. Specifically, in terms of energy policies and implications, the majority were aware of the problems related to foreign energy resources, political conflicts and the increase in energy demand. In terms of energy resources, the majority were aware of the impacts of fossil fuels as depletable resource, the environmental impacts of fossil fuels, limited use of renewable energy, risk perceptions about

nuclear energy and management of nuclear energy power plant. That awareness might contribute to the moderate relationship between self-determined motivation and eco-management type of motivation. While PSTs mentioned these problems, three sources of knowledge were distinct: personal experience, news bulletins or the Internet and the courses. In courses, they mentioned documentaries, cases (e.g., life stories exemplifying the problems and issues), and field trips. These sources might have a role in their high awareness.

- On the other hand, they lacked awareness about some problems related to energy policies and implications, energy resources and the relationship between energy use/production/conservation and global warming. In particular, in terms of energy policies and implications, they lacked awareness of problems related to governmental support, energy consumption inequality, illegal electricity, electric and heating expenses, fundamental knowledge about energy and public participation in decision-making. Related to the problems related to energy resources, they lacked awareness about the social impacts of fossil fuels, the problem related to economy in fossil fuels, the environmental impacts of renewable energy resources, the social impacts of hydroelectric power plants, the planning of hydroelectric power plants, the environmental and social impacts of wind power plants, the environmental impacts of wave power plants, the environmental impacts of nuclear energy power plants and the problems related to economy of nuclear energy power plants. Low level of awareness about these problems and issues might contribute to the weak relationship between self-determined motivation and persuasion behavior. That is, even PSTs with self-determined motivation might hesitate to communicate with people to persuade them to conserve energy since they were unaware of these problems and issues.

5.5 Implications for educational policy and practice

The results of this present study highlight potential implications for both research on environmental education and science teacher education. The ultimate goal of environmental education is to promote pro-environmental behaviors (Hungerford & Volk, 1992). As a type of pro-environmental behavior, energy conservation behavior (ECB), which is a mitigation strategy for climate change, is the main concern of this study. The results of this study revealed that ECB should be explored with types of behavior (e.g., eco-management and persuasion) rather than in a unidimensional manner. In this way, an in-depth understanding about the relationship between various variables (e.g., demographic, cognitive and affective variables) and pro-environmental behaviors is provided (Erdogan et al., 2012). Correspondingly, the relationships of affective variables with ECB types showed a great deal of variation. As an implication, exploring ECB through types enriches our understanding of this behavior.

Similar to exploring behavior through types, awareness should be investigated regarding types. In this way, the role of awareness is understood better. For instance, the PSTs in this study were aware of the problems related to foreign energy dependence of Turkey and wasteful energy use, but the majority were not aware of the impacts of energy resources on environment and society. Being aware of wasteful use and foreign energy dependence might contribute to eco-management type of ECB, but for persuasion behavior, awareness of other dimensions may need to be increased. In a similar vein, in order to decrease amotivation for ECB and increase self-determined motivation of PSTs, their awareness should be raised from multiple perspectives.

Another implication is related to teacher education programs. PSTs' awareness of energy related problems, issues and solutions showed a considerable variation. The PSTs who took more than one environmental education course with the EE/ESD approach and the STS with argument-driven inquiry regarding energy related problems and issues had more awareness of energy-related problems and issues.

These courses used several teaching strategies and tools which provided first hand experiences (e.g., field trips), real life connections (e.g., case studies, documentaries) and a discussion environment (e.g., argument-driven issues). Thus, the number of environmental education courses with the environmental EE/ESD approach and courses enabling a discussion environment from multiple perspectives (e.g., Science, Technology and Society course) seem very important to improve awareness of PSTs. In a similar vein, the study of Palmer, Suggate, Robottom and Hart (1999) strongly suggest the use of the EE/ESD approach, which enables life experiences, in order to increase long-term environmental awareness. In addition to this, recently, UNESCO published a document for goals of education for sustainable development. Among these goals, integrating ESD to teacher education programs is accepted as crucially important, and awareness of renewable energy and impacts of energy resources are emphasized within those goals. Considering all these reasons, the program of science teacher education should involve problems, issues and solutions related to energy, and the EE/ESD approach with various teaching methods should be adopted.

Providing experience and real life connections through the EE/ESD approach may serve the satisfaction of basic psychological needs as well. The results of this study showed that basic psychological needs and ECB have a relationship. This result was supported by previous studies (e.g., Cooke et al., 2016). Through the EE/ESD approach, this relationship can be strengthened. The previous studies showed that satisfaction of these needs in courses contributes to the increase in self-determined motivation (Darner, 2012; Karaarslan et al., 2014; Karpudewan & Mohd Ali Khan, 2017). Energy related problems and issues are complex and multidimensional (e.g., policy, economy, society, and environment). In order to support sustainability of earth, the importance of energy conservation should be introduced with this complex feature (Bloom et al., 2015; Harris & Roach, 2013; Tietenberg & Lewis, 2015). If PSTs are led to discover these problems and issues, they might both experience scientific reasoning of energy conservation and feel responsible for taking action. Arrangement of field trips, case studies, documentaries, carbon footprint activities and argument driven learning environment can be useful for

increasing their awareness from a multidimensional perspective. In addition this, PSTs, who experienced the impacts of energy resources in their hometown (e.g., hydroelectric power plants, wind power plants), can be encouraged to share their experiences, and their story can be a case in the course. In this way, their self-determined motivation and ECB types may be promoted.

5.6 Recommendations for further research

This study has some limitations, and they were mentioned with suggestions for future studies under this title. To begin with, the sample of quantitative part of the study was selected conveniently. This is a barrier to the generalizability of the findings to the population. For that reason, further studies which use random sampling should be conducted. In this way, the generalizability of the findings concerning the energy conservation behavior (ECB) and the related variables would be more possible. Through the studies using different samples, the validity and reliability of instruments can be verified.

This study showed that exploring ECB through types (e.g., co-management and persuasion) provides sophisticated understanding. Although some interpretations are made for differentiating results for ECB types, further studies are required to verify these interpretations. For example, the EE/ESD approach courses might satisfy autonomy, competence and relatedness needs of PSTs, and their self-determined motivation. In this way, their ECB types might be improved. However, how these needs are satisfied and how the internalization of this behavior types proceeds through this approach is not known. Further studies may shed light on these processes. Although the study of Darner (2012) and Karaarslan et al. (2014) provide some evidence about the basic psychological needs and motivation toward environment, how the behavior is internalized and how these needs are satisfied in an EE/ESD approach course are not clear. Moreover, studies specific to energy

education is very limited, and further studies exploring these processes specific to energy education are needed.

In this model, direct relationships with the types of energy conservation behavior were investigated since these relationships have not been investigated for pre-service science teachers (PSTs) and for these types of behaviors in the literature so far. However, indirect relationships are also important to investigate. Studies have shown that motivation types have a mediation role in the relationship between basic psychological needs and ECB (e.g., Cooke et al., 2015; Sweeney et al., 2014). The indirect relationships among the variables in the model should be investigated in further studies.

The focus of this study was to investigate ECB through affective variables. It was found that their motivation, basic psychological needs and attitudes were important in their ECB. In addition to these affective variables, it was found that their awareness might have a role in the relationship between those affective variables and ECB. Further quantitative studies, which focus on PSTs' awareness including both their knowledge on energy related problems and issues and their concern for them, should be conducted. Investigating the role of their awareness quantitatively would contribute better to our understanding of ECB.

It was observed in this study that PSTs who took more than one course with the EE/ESD approach and the argument driven Science, Technology and Society courses have more awareness of energy related problems and issues. However, the analysis of this study might be limited in attributing this result to these courses. Further studies need to be carried out to support this inference. Experimental studies, exploring the effect of field trips, case-based instruction and argumentation on PSTs' awareness of energy related problems and issues, their motivation and attitude toward energy conservation would contribute highly to the literature. However, the effects of these field trips on PSTs' attitude toward these trips and whether they will organize such trips in their professional lives in the future are unknown. As Ateskan and Lane (2016) stated, studies on field trips are very limited in Turkey and further studies should be conducted within pre-service teacher

education. Specifically, there is a gap in the literature regarding the effect of field trips on PSTs' awareness of energy-related problems and issues, their attitudes, motivation and self-efficacy in teaching energy related problems and issues. Further research is suggested to fill this gap in the literature and to support the findings of the current study regarding the contribution of field trips.

In addition to the field trips, the use of case studies for energy related problems and issues (e.g., cases related to climate change) is also significant. Case study teaching is very useful for raising awareness among learners. Providing concrete information on energy conservation is claimed to be more effective than giving general information (Ek & Soderholm, 2010). Using case studies might provide concrete information to PSTs. The nature of energy topic is very convenient for this teaching method since this topic covers many social issues such as policy, economy and environment (Herreid, 2007). However, the literature regarding the use of this method with PSTs and energy related topics and issues is very limited. Further studies are suggested to fill this gap.

While the PSTs mentioned their awareness related to energy problem and issues, they also talked about their energy conservation behaviors. During the explanations, it was observed that they referred to their values and ethical issues. Studies with the VBN theories showed that energy conservation is related to participants' values (e.g., Poortinga et al., 2004; Sahin, 2013). However, the number of studies on ethical issues is limited. Further studies may shed light on the relationship between energy conservation and ethical issues. For instance, studies exploring the moral reasoning in ECB may improve our understanding of PSTs' ECB.

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APPENDICES



APPENDIX A. DEMOGRAPHICS QUESTIONNAIRE

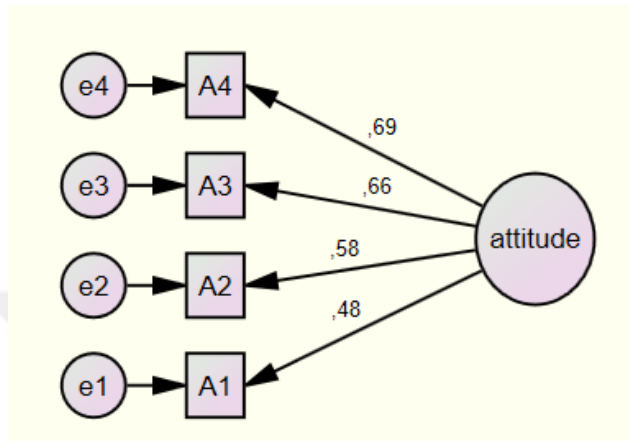
Kişisel Bilgiler

1. Cinsiyetiniz: ☐ Kadın ☐ Erkek
2. Şu anda kaçınıcı sınıftasınız : ☐ 3. sınıf ☐ 4.sınıf
3. E-mail adresiniz:
4. Öğrenim gördüğünüz üniversitenin adı:
5. Daha önce enerji verimliliği veya enerji tasarrufu ile ilgili bir seminere veya toplantıya katıldınız mı? ☐ Evet ☐ Hayır
6. Şu ana kadar üniversitede Çevre ile ilgili aldığınız dersler neler?
.....
...
7. Çocukluğunuzun pek çoğunluğunu (18 yaşına gelene kadar) geçirdiğiniz bölgede aşağıdakilerden hangisi vardı?
☐ Maden işletmesi ☐ Hidroelektrik santral
☐ Termik Santral ☐ Hiçbiri
8. Çocukluğunuzun pek çoğunluğunu (18 yaşına gelene kadar) geçirdiğiniz bölgeyi aşağıdakilerden hangisi ile tanımlarsınız?
☐ Kırsal alan (Nüfusu <2,500) ☐ Kentsel Alan (Nüfusu 25,000 ile 100,000 arası)
☐ Kasaba (Nüfusu 2,500 ile 25,000 arası) ☐ Şehir (Nüfusu 100,000den fazla)
9. Annenizin Eğitim Durumu: Babanızın Eğitim Durumu:
☐ Hiç okula gitmemiş ☐ Hiç okula gitmemiş
☐ İlkokul ☐ İlkokul
☐ Ortaokul ☐ Ortaokul
☐ Lise ☐ Lise
☐ Üniversite ☐ Üniversite
☐ Yüksek lisans / Doktora ☐ Yüksek lisans /Doktora
10. Yaşadığınız yer:
☐ Yurtta kalıyorum. ☐ Ev arkadaşlarımla yaşıyorum ☐ Ailemle yaşıyorum

**APPENDIX B. ATTITUDES TOWARD ENERGY CONSERVATION
SCALE**

Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden <u>birini</u> işaretleyiniz.	Kesinlikle Katılmıyorum	Katılmıyorum	Kararsızım	Katılıyorum	Kesinlikle Katılıyorum
1. Enerji tasarrufu yapmak bir çok güçlük içeriyor.	1	2	3	4	5
2. Enerji tasarrufu yapmak çok fazla zamanımı alıyor.	1	2	3	4	5
3. Enerji tasarrufu yaptığım zaman yaşam kalitem azalacaktır.	1	2	3	4	5
4. Enerji tasarrufu yapmak, yaşam konforumu azaltmam gerektiği anlamına geliyor.	1	2	3	4	5

**APPENDIX C. CFA MODEL OF THE ATTITUDES TOWARD ENERGY
CONSERVATION INSTRUMENT**



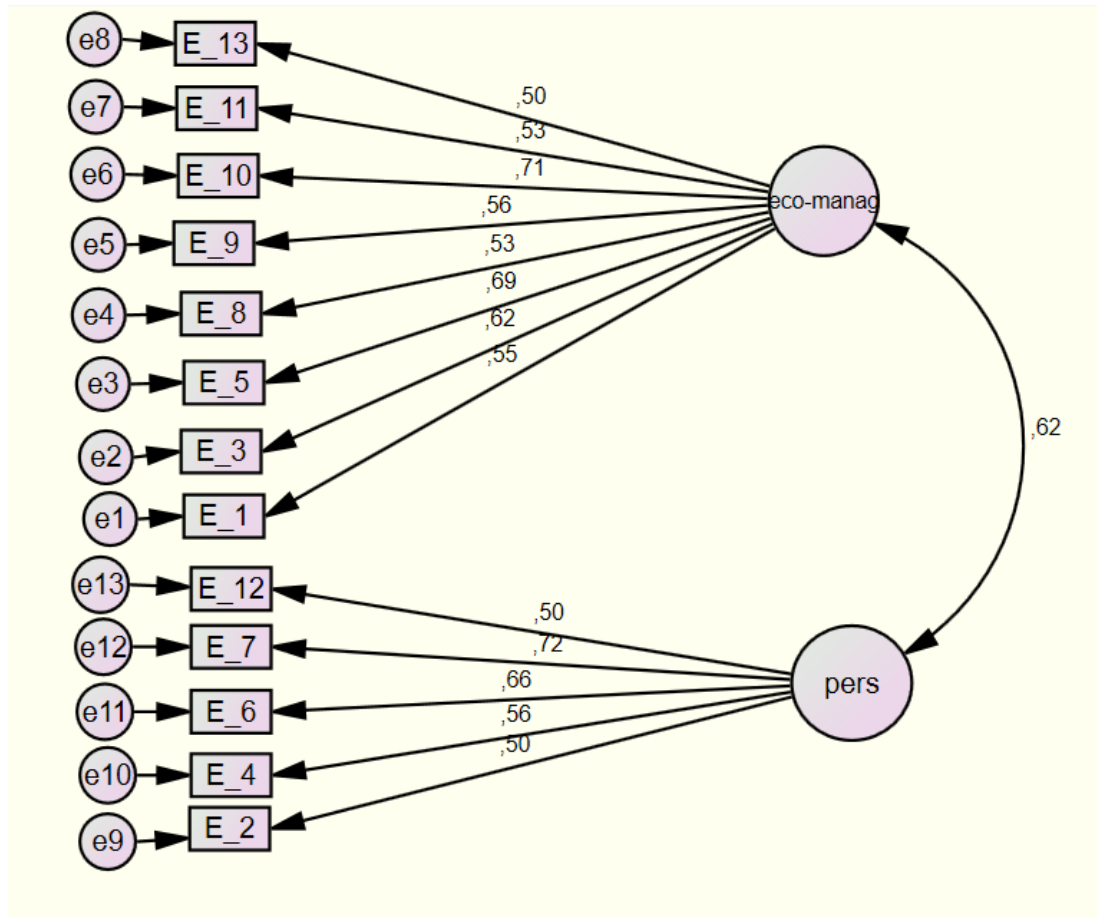
**APPENDIX D. ENERGY CONSERVATION BEHAVIOR INSTRUMENT
USED IN THE SECOND PILOT**

Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden <u>birini</u> işaretleyiniz.	Hiçbir zaman	Nadiren	Bazen	Sıklıkla	Her zaman
1. Suyu tasarruflu kullanırım.	1	2	3	4	5
2. Ailemi enerji verimliliği yüksek ev aletleri almaları konusunda teşvik ederim.	1	2	3	4	5
3. Gereksiz yere yanan lambaları kapatırım	1	2	3	4	5
4. Enerji tasarrufu için ailemi/ ev arkadaşlarımı/yurt yönetimini damlayan sıcak su musluğunu tamir etmeleri konusunda teşvik ederim	1	2	3	4	5
5. Gereksiz yere takılı olan fişleri prizden çekerim.	1	2	3	4	5
6. Enerji tasarrufu yapmaları için ailemi/ ev arkadaşlarımı/yurt yönetimini geceleri kombinin/kaloriferin ısısını düşürmeleri için teşvik ederim.	1	2	3	4	5
7. Enerji tasarruflu kompakt floresan ampuller almaları konusunda ailemi/ev arkadaşlarımı/ yurt yönetimini teşvik ederim.	1	2	3	4	5
8. Çamaşır ve bulaşık makinesini çalıştırmak için tamamen dolmasını beklerim.	1	2	3	4	5
9. Bilgisayarı kullanmadığımda kapatırım	1	2	3	4	5
10. İşim bittiğinde elektrikli aletlerin fişini çekerim.	1	2	3	4	5
11. Dişlerimi fırçalarken suyu kullanmadığım sırada musluğu kapatırım.	1	2	3	4	5
12. Enerji tasarrufu yapmak için banyoda kısa süre (10 dk. az) kalırım	1	2	3	4	5
13. Ailemi çamaşır makinesini düşük sıcaklıkta ve ön yıkamasız çalıştırmaları konusunda teşvik ederim.	1	2	3	4	5
14. Kullanmadığım zamanlarda TV, DVD oynatıcı gibi elektrikli cihazları düğmesinden kapatırım.	1	2	3	4	5

**APPENDIX E. ENERGY CONSERVATION BEHAVIOR INSTRUMENT
USED IN THE MAIN STUDY**

Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden <u>birini</u> işaretleyiniz.	Hiçbir zaman	Nadiren	Bazen	Sıklıkla	Her zaman
1. Suyu tasarruflu kullanırım.	1	2	3	4	5
2. Ailemi enerji verimliliği yüksek ev aletleri almaları konusunda teşvik ederim.	1	2	3	4	5
3. Gereksiz yere yanan lambaları kapatırım.	1	2	3	4	5
4. Enerji tasarrufu için ailemi/ ev arkadaşlarımı/yurt yönetimini damlayan sıcak su musluğunu tamir etmeleri konusunda teşvik ederim.	1	2	3	4	5
5. Gereksiz yere takılı olan fişleri prizden çekerim.	1	2	3	4	5
6. Enerji tasarrufu yapmaları için ailemi/ ev arkadaşlarımı/yurt yönetimini geceleri kombinin/kaloriferin ısınısını düşürmeleri için teşvik ederim.	1	2	3	4	5
7. Enerji tasarruflu kompakt floresan ampuller almaları konusunda ailemi/ev arkadaşlarımı/ yurt yönetimini teşvik ederim.	1	2	3	4	5
8. Çamaşır ve bulaşık makinesini çalıştırmak için tamamen dolmasını beklerim.	1	2	3	4	5
9. Bilgisayarı kullanmadığımda kapatırım.	1	2	3	4	5
10. İşim bittiğinde elektrikli aletlerin fişini çekerim.	1	2	3	4	5
11. Dişlerimi fırçalarken suyu kullanmadığım sırada musluğu kapatırım.	1	2	3	4	5
12. Ailemi çamaşır makinesini düşük sıcaklıkta ve ön yıkamasız çalıştırmaları konusunda teşvik ederim.	1	2	3	4	5
13. Kullanmadığım zamanlarda TV, DVD oynatıcı gibi elektrikli cihazları düğmesinden kapatırım	1	2	3	4	5

APPENDIX F. CFA MODEL OF THE ENERGY CONSERVATION BEHAVIOR SCALE



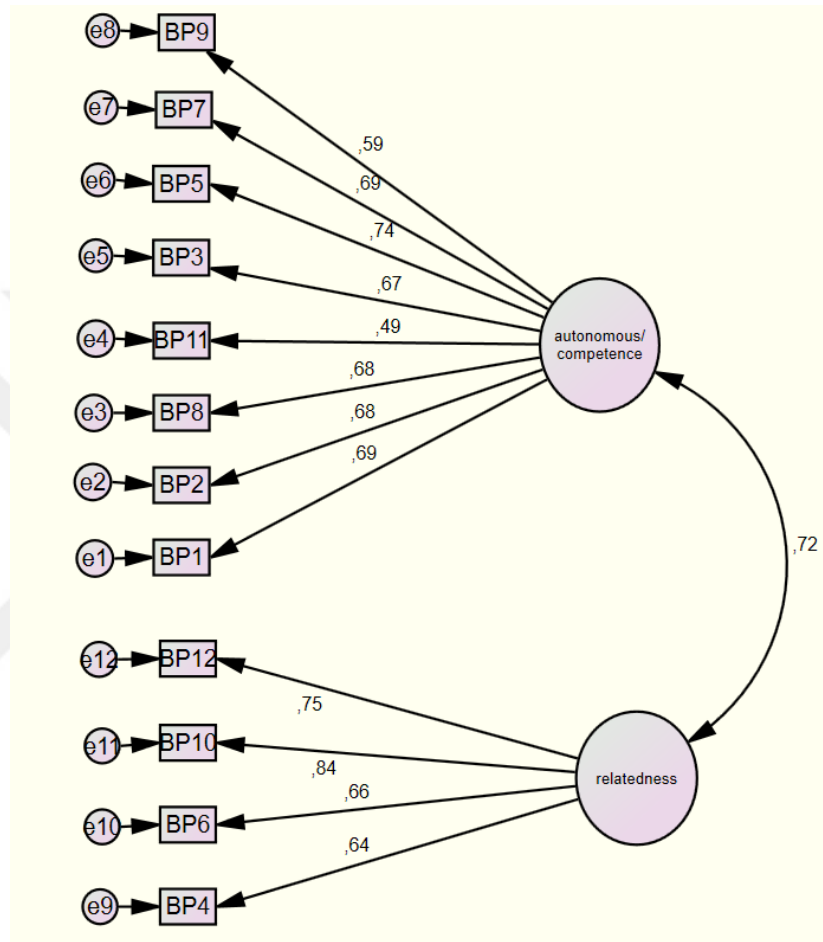
**APPENDIX G. BASIC PSYCHOLOGICAL NEEDS FOR ENERGY
CONSERVATION INSTRUMENT USED IN THE PILOT STUDY**

Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden birini işaretleyiniz.	Kesinlikle Katılmıyorum						Kesinlikle Katılıyorum
1. Enerji tasarrufu hakkında ne yapacağım ile ilgili söz sahibiyim.	1	2	3	4	5	6	7
2. Enerji tasarrufu yapma konusunda benim de söyleyeceklerim var.	1	2	3	4	5	6	7
3. Enerji tasarrufu konusunda bilgiliyim.	1	2	3	4	5	6	7
4. Enerji tasarrufu yapan insanlarla aramda bir dostluk duygusu hissediyorum.	1	2	3	4	5	6	7
5. Enerji tasarrufu ile ilgili ne yapacağım konusunda kısıtlanmıyorum.	1	2	3	4	5	6	7
6. Enerji tasarrufu ile ilgili yöntemleri uygulama konusunda kendime güveniyorum.	1	2	3	4	5	6	7
7. Enerji tasarrufu yapan insanlarla benzer kaygılar taşıdığımı düşünüyorum.	1	2	3	4	5	6	7
8. Enerji tasarrufu yaparken karşıma çıkabilecek zorluklarla başa çıkabilirim.	1	2	3	4	5	6	7
9. Enerji tasarrufu ile ilgili ne yapacağıma kendim karar verebilirim.	1	2	3	4	5	6	7
10. Kullandığım enerji miktarını kontrol edebilirim.	1	2	3	4	5	6	7
11. Enerji tasarrufu yapan insanlarla ortak bir paydada buluştuğumuzu düşünüyorum.	1	2	3	4	5	6	7
12. Enerji tasarrufu ile ilgili ne yapacağım konusunda özgürüm.	1	2	3	4	5	6	7
13. Enerji tasarrufu yapan insanlarla ortak bir sosyal grupta olduğumuzu düşünüyorum	1	2	3	4	5	6	7

**APPENDIX H. BASIC PSYCHOLOGICAL NEEDS FOR ENERGY
CONSERVATION INSTRUMENT USED IN THE MAIN STUDY**

Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden <u>birini</u> işaretleyiniz.	Kesinlikle Katılmıyorum						Kesinlikle Katılıyorum
1. Enerji tasarrufu hakkında ne yapacağım ile ilgili söz sahibiyim.	1	2	3	4	5	6	7
2. Enerji tasarrufu yapma konusunda benim de söyleyeceklerim var.	1	2	3	4	5	6	7
3. Enerji tasarrufu konusunda bilgiliyim.	1	2	3	4	5	6	7
4. Enerji tasarrufu yapan insanlarla aramda bir dostluk duygusu hissediyorum.	1	2	3	4	5	6	7
5. Enerji tasarrufu ile ilgili yöntemleri uygulama konusunda kendime güveniyorum.	1	2	3	4	5	6	7
6. Enerji tasarrufu yapan insanlarla benzer kaygılar taşıdığımı düşünüyorum.	1	2	3	4	5	6	7
7. Enerji tasarrufu yaparken karşıma çıkabilecek zorluklarla başa çıkabilirim.	1	2	3	4	5	6	7
8. Enerji tasarrufu ile ilgili ne yapacağıma kendim karar verebilirim.	1	2	3	4	5	6	7
9. Kullandığım enerji miktarını kontrol edebilirim.	1	2	3	4	5	6	7
10. Enerji tasarrufu yapan insanlarla ortak bir paydada buluştuğumuzu düşünüyorum.	1	2	3	4	5	6	7
11. Enerji tasarrufu ile ilgili ne yapacağım konusunda özgürüm.	1	2	3	4	5	6	7
12. Enerji tasarrufu yapan insanlarla ortak bir sosyal grupta olduğumuzu düşünüyorum.	1	2	3	4	5	6	7

**APPENDIX I. CFA MODEL OF THE BASIC PSYCHOLOGICAL NEEDS
FOR ENERGY CONSERVATION INSTRUMENT**



**APPENDIX J. MOTIVATION TOWARD ENERGY CONSERVATION
INSTRUMENT USED IN THE PILOT STUDY**

Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden <u>birini</u> işaretleyiniz.	Kesinlikle Katılmıyorum						Kesinlikle Katılıyorum
1. Enerji tasarrufu yapmak akılcı bir davranıştır.	1	2	3	4	5	6	7
2. Enerji tasarrufu yapmak rutin davranışlarımdan birisidir.	1	2	3	4	5	6	7
3. Ailemin ısrarı ile enerji tasarrufu yaparım.	1	2	3	4	5	6	7
4. Enerji tasarrufu için bir şeyler yapmasaydım pişman olurdum.	1	2	3	4	5	6	7
5. Enerji tasarrufu yaparak gelecek nesillerin daha yeşil bir çevreye sahip olmalarına yardımcı olurum	1	2	3	4	5	6	7
6. Enerji tasarrufu konusunda önemli gelişmeler kaydedilmezken, enerji tasarrufu yapmak bana anlamlı gelmiyor.	1	2	3	4	5	6	7
7. Enerji tasarrufuna katkıda bulunmaktan keyifduyarım.	1	2	3	4	5	6	7
8. Enerji tasarrufu yaparken boşuna zaman harcıyormuşum gibi bir izlenime kapılıyorum.	1	2	3	4	5	6	7
9. Vicdanımı rahatlatmak için enerji tasarrufu yaparım.	1	2	3	4	5	6	7
10. Enerji tasarrufu yaparak çevre kalitesinin artmasına katkı sağlamak hoşuma gider.	1	2	3	4	5	6	7
11. Enerji tasarrufu yapmasaydım kendimi suçlu hissederdim.	1	2	3	4	5	6	7
12. Eleştirilmekten kaçındığım için enerji tasarrufu yaparım.	1	2	3	4	5	6	7
13. Enerji tasarrufu yaparak çevre kirliliğinin azalmasına yardımcı olurum.	1	2	3	4	5	6	7
14. Enerji tasarrufu yapmasaydım kendimi kötü hissederdim.	1	2	3	4	5	6	7
15. Enerji tasarrufu yaparak bütçeme katkıda bulunurum.	1	2	3	4	5	6	7

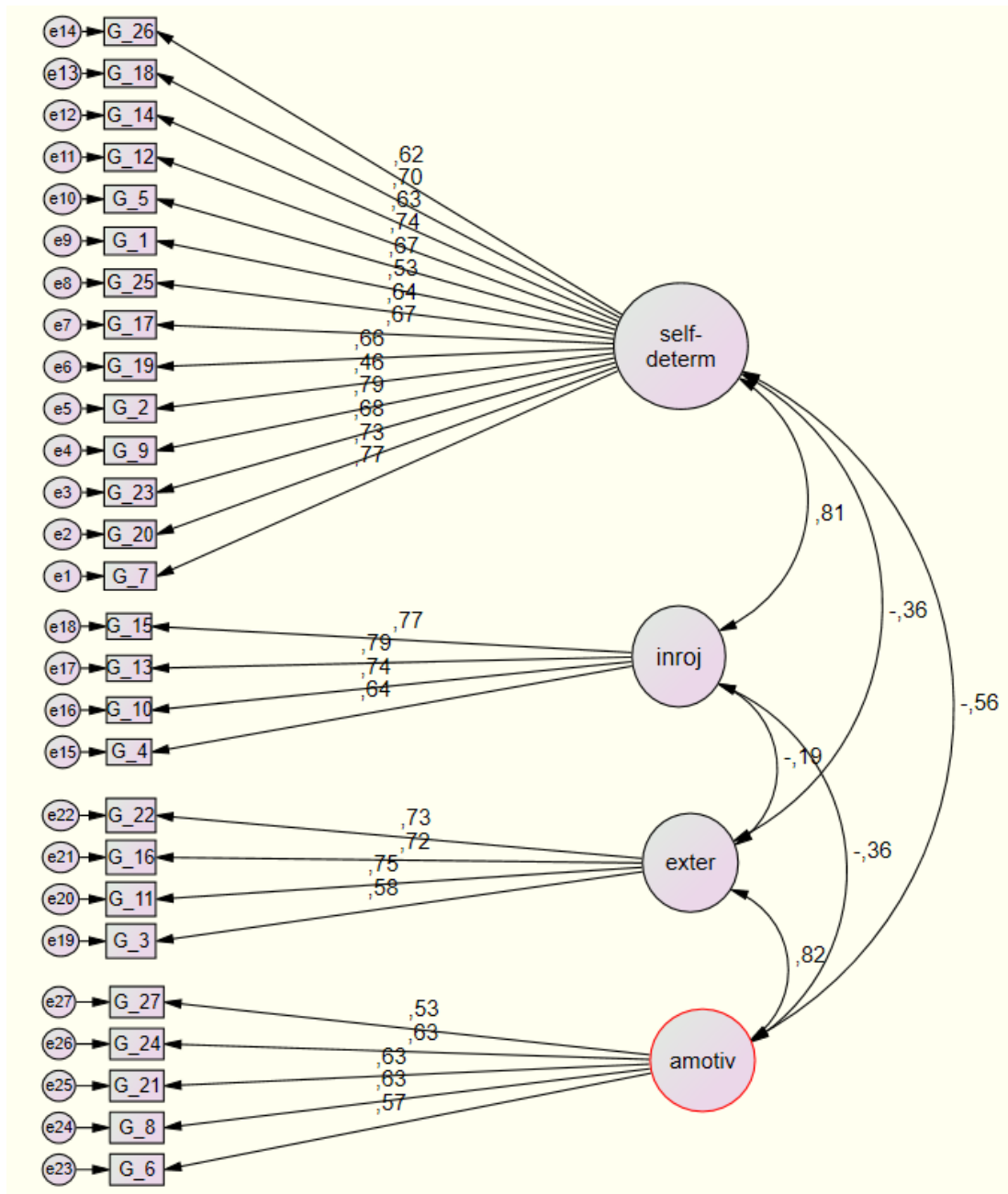
Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden <u>birini</u> işaretleyiniz.	Kesinlikle Katılmıyorum						Kesinlikle Katılıyorum
16. Enerji tasarrufu için bir şeyler yapmasaydım huzursuz olurdum.	1	2	3	4	5	6	7
17. Takdir edilmek için enerji tasarrufu yaparım.	1	2	3	4	5	6	7
18. Yaşam anlayışımın doğası gereği enerji tasarrufu yaparım.	1	2	3	4	5	6	7
19. Enerji tasarrufu ile ilgili bir şeyler yapmanın iyi bir fikir olduğunu düşünüyorum.	1	2	3	4	5	6	7
20. Etrafımdaki insanlar enerji tasarrufuna önem veriyorlar.	1	2	3	4	5	6	7
21. Enerji tasarrufu yapmanın bana ne kazandıracağı konusunda bir fikrim yok.	1	2	3	4	5	6	7
22. Enerji tasarrufu yapmak yaşam tarzımın bir parçasıdır.	1	2	3	4	5	6	7
23. Enerji ile ilgili durumun neden iyiye gitmediğini merak ediyorum.	1	2	3	4	5	6	7
24. Enerji tasarrufu için bir şeyler yapmış olmanın verdiği duyguyu severim.	1	2	3	4	5	6	7
25. Enerji tasarrufu yaparak çevreye nasıl yardımcı olacağımı anlamıyorum.	1	2	3	4	5	6	7
26. Çevremdeki insanların ısrarı ile enerji tasarrufu yaparım.	1	2	3	4	5	6	7
27. Enerji tasarrufu ile ilgili yeni şeyler öğrenmek hoşuma gider.	1	2	3	4	5	6	7
28. Enerji tasarrufu yapmak alışkanlıklarımdan birisidir	1	2	3	4	5	6	7
29. Enerji tasarrufu yapmanın bütçeme nasıl bir katkı sağladığını bilmiyorum.	1	2	3	4	5	6	7
30. Enerji tasarrufu yapmak yaşamımın tamamlayıcı bir parçasıdır.	1	2	3	4	5	6	7
31. Enerji tasarrufu yapmak mantıklı bir şeydir.	1	2	3	4	5	6	7
32. Enerji ham maddeleri hızla tüketilirken, bireysel yaptığım enerji tasarrufunun çevreyi iyileştireceğine inanmıyorum.	1	2	3	4	5	6	7

**APPENDIX K. MOTIVATION TOWARD ENERGY CONSERVATION
INSTRUMENT USED IN THE MAIN STUDY**

Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden <u>birini</u> işaretleyiniz.	Kesinlikle Katılmıyorum						Kesinlikle Katılıyorum
1. Enerji tasarrufu yapmak akılcı bir davranıştır.	1	2	3	4	5	6	7
2. Enerji tasarrufu yapmak rutin davranışlarımdan birisidir.	1	2	3	4	5	6	7
3. Ailemin ısrarı ile enerji tasarrufu yaparım.	1	2	3	4	5	6	7
4. Enerji tasarrufu ile ilgili bir şeyler yapmasaydım pişman olurdum.	1	2	3	4	5	6	7
5. Enerji tasarrufu yaparak gelecek nesillerin daha iyi bir çevreye sahip olmalarına yardımcı oluyorum.	1	2	3	4	5	6	7
6. Enerji tasarrufu konusunda önemli gelişmeler kaydedilmezken, enerji tasarrufu yapmak bana anlamlı gelmiyor.	1	2	3	4	5	6	7
7. Enerji tasarrufuna katkıda bulunmaktan keyif duyarım.	1	2	3	4	5	6	7
8. Enerji tasarrufu yaparken boşuna zaman harcıyormuşum gibi bir izlenime kapılıyorum.	1	2	3	4	5	6	7
9. Enerji tasarrufu yaparak çevre kalitesinin artmasına katkı sağlamak hoşuma gider.	1	2	3	4	5	6	7
10. Enerji tasarrufu yapmasaydım kendimi suçlu hissederdim.	1	2	3	4	5	6	7
11. Eleştirilmekten kaçındığım için enerji tasarrufu yaparım.	1	2	3	4	5	6	7
12. Enerji tasarrufu yaparak çevre kirliliğinin azalmasına yardımcı olurum.	1	2	3	4	5	6	7
13. Enerji tasarrufu yapmasaydım kendimi kötü hissederdim.	1	2	3	4	5	6	7
14. Enerji tasarrufu yaparak bütçeme katkıda bulunurum.	1	2	3	4	5	6	7
15. Enerji tasarrufu için bir şeyler yapmasaydım huzursuz olurdum.	1	2	3	4	5	6	7

Lütfen aşağıda verilen her bir ifadeye katılım durumunuzu gösteren seçeneklerden <u>birini</u> işaretleyiniz.	Kesinlikle Katılmıyorum						Kesinlikle Katılıyorum
16. Takdir edilmek için enerji tasarrufu yaparım.	1	2	3	4	5	6	7
17. Yaşam anlayışımın doğası gereği enerji tasarrufu yaparım.	1	2	3	4	5	6	7
18. Enerji tasarrufu ile ilgili bir şeyler yapmanın iyi bir fikir olduğunu düşünüyorum.	1	2	3	4	5	6	7
19. Enerji tasarrufu yapmak yaşam tarzımın bir parçasıdır.	1	2	3	4	5	6	7
20. Enerji tasarrufu için bir şeyler yapmış olmanın verdiği duyguyu severim.	1	2	3	4	5	6	7
21. Enerji tasarrufu yaparak çevreye nasıl yardımcı olacağımı anlamıyorum.	1	2	3	4	5	6	7
22. Çevremdeki insanların ısrarı ile enerji tasarrufu yaparım.	1	2	3	4	5	6	7
23. Enerji tasarrufu ile ilgili yeni şeyler öğrenmek hoşuma gider.	1	2	3	4	5	6	7
24. Enerji tasarrufu yapmanın bütçeme nasıl bir katkı sağladığını bilmiyorum.	1	2	3	4	5	6	7
25. Enerji tasarrufu yapmak yaşamımın tamamlayıcı bir parçasıdır.	1	2	3	4	5	6	7
26. Enerji tasarrufu yapmak mantıklı bir şeydir.	1	2	3	4	5	6	7
27. Enerji ham maddeleri hızla tüketilirken, bireysel yaptığım enerji tasarrufunun çevreyi iyileştireceğine inanmıyorum.	1	2	3	4	5	6	7

APPENDIX L. CFA MODEL OF MOTIVATION TOWARD ENERGY CONSERVATION INSTRUMENT



APPENDIX M. PRESERVICE TEACHER INTERVIEW PROTOCOL

Öğretmen Adayının Adı:

Öğretmen Adayının Öğrenim Gördüğü Üniversite:

Öğretmen Adayının sınıfı:

Ben Birgül Çakır. Fen Bilgisi Eğitimi alanında, Orta Doğu Teknik Üniversitesinde doktora yapıyorum. Doktora tezim kapsamında, Fen Bilgisi öğretmen adaylarının enerji kaynakları ile ilgili problem ve meseleler hakkındaki görüşlerini, enerji tasarrufu davranışlarını, enerji tasarrufuna karşı tutumları ve motivasyonlarını araştırıyorum. Ayrıca, üniversitede aldıkları derslerde enerji konusunun öğretimi ile ilgili hangi konuların ele alındığını ve bunun hangi öğretim yöntem ve teknikleri kullanılarak sizlere öğretildiği ile ilgili veri topluyorum.

Vereceğiniz tüm bilgiler akademik çalışmamın kapsamında kullanılacak olup, isminiz ve üniversitenizin adı hiçbir yerde kullanılmayacaktır. Sizinle yapacağım görüşme yaklaşık bir saat sürecektir. Görüşme sırasında istediğiniz soruyu sorabilir, cevaplamak istemediğiniz soru olursa, bu soruyu geçmemi isteyebilir veya görüşmeyi durdurabilirsiniz.

Çalışmama sunmuş olduğunuz katkı için teşekkür ederim.

1. Yaşınız nedir ve kaçınıcı sınıftasınız?
2. Büyüdüğünüz yerde termik santral, HES, maden ocağı ya da fabrika var mıydı?
3. Enerji problemleri ve meseleleri ile ilgili bilgi kaynakların neler?
4. Enerji ile ilgili haberler ne kadar dikkatinizi çekiyor?
5. Sizce Türkiyede enerji ile ilgili çözüm bekleyen problemler neler?
6. Sizce bu problemlerin çözülmesi zor mu? Neden/ Neden değil?
7. Sizce dünyada enerji ile ilgili çözüm bekleyen problemler neler?
8. Sizce bu problemlerin çözülmesi zor mu? Neden/ Neden değil?
9. Enerjinin üretimi ile ilgili geleceğe dair umutların ve korkuların neler?
10. Enerjinin kullanımı ile ilgili geleceğe dair umutların ve korkuların neler?
11. Enerji tasarrufu ile ilgili geleceğe dair umutların ve korkuların neler?
12. Enerji konusu ile iklim değişikliği arasında nasıl bir ilişki var mı sence?
13. Enerji tasarrufu ile iklim değişikliği arasında nasıl bir ilişki var sence?

14. Üniversitede aldığınız derslerin hangilerinde enerji ile ilgili problem ve konulara yer veriliyor?

15. Bu derslerde enerji ile ilgili hangi problem ve konulara yer veriliyor? (Bir önceki soruda bahsettiğiniz her bir ders için cevaplayınız)

16. Üniversitede aldığınız derslerde enerji konusunda ne tür konu ve kavramlar öğretiliyor?

- Enerjinin kullanımı/tüketimi ve üretimi ile ilgili nelere yer veriliyor?
- Enerji tasarrufu kapsamında nelere yer veriliyor?
- Enerji ve sürdürülebilirlik arasındaki ilişkiye yer veriliyor mu? Evetse, nasıl?
- Enerji tasarrufu ve sürdürülebilirlik arasındaki ilişkiye yer veriliyor mu? Evetse, nasıl?
- Enerji ve iklim değişikliği arasındaki ilişkiye yer veriliyor mu? Evetse, nasıl?
- Enerji tasarrufu ve iklim değişikliği arasındaki ilişkiye yer veriliyor mu? Evetse, nasıl?

17. Üniversitede enerji ile ilgili konular anlatılırken öğretim elemanları ne tür öğretim yöntem ve teknikleri kullandılar?

18. Bu konuyu öğretirken hangi öğrenme ortamlarını kullandılar? (ör; dış mekan-outdoor, sınıf, laboratuvar)

19. Öğretim elemanlarının enerji konusunu anlatırken kullandıkları öğretim materyalleri neler? (ör; kitaplar, makaleler, örnek olay hikayeleri, vb)

APPENDIX N. TRANSLATIONS

- "Gelecekte bazı savaşların başlayacağına inanıyorum. Bugün bile bu savaş yaşanıyor. Ülkeler bugün bile bu kaynak (petrol) için birbirleriyle kavga ediyorlar. " (PST2)
"I believe that some wars will start in the future. Even today, this war is happening. Countries are fighting with each other for this resource [oil] even today." (PST2)
- Çünkü başta hani nükleer enerji santrallerinin kurulmasını isteyen bir devlet yönetimi var. Oysa, Almanya'dakiler kapatıp artık onun hani zararlı olduğunu ya da en azından gereksiz olduğunu düşünüyorlar. Kapatıp onun yerine Yeşil Almanya projesi yapıyorlar, işte her taraf güneş enerjisi, her taraf orman, her taraf faydalı şeylerle dolacak. Tersine bizde de nükleer enerji isteyen bir yönetim var başta. Ve aldıkları oya bakarsak onların düşünce tarzında olan pek çok insan var, Türkiye'nin yarısı onlarla aynı düşüncede. Şimdi onlar nükleer enerji iyi, biz yapacağız dedikten sonra onları destekleyen pek çok insan oldu, gördük. Hatta benim bildiğim Sinopa izin çıktı. Yani izni çıktı artık başladıktan sonra geri dönüş yok. (PST18)

"Because the government in our country wants the construction of nuclear energy power plants. By contrast, Germany is planning to shut all nuclear energy power plants. Instead, they started *Green Germany* project and everywhere will be covered with solar energy, forests and useful things. On the contrary, the government in Turkey favors nuclear energy power plant and if we look at their vote rate, there are so many people, who share the same view. Indeed, half of population has the same view with them. When they told that the nuclear energy is good, so many people supported them. We experienced this. In fact, they will construct the second one in Sinop. As I know, they also took permissions for Sinop. When they take the permissions, there is no return" (PST18)

- Enerjiye ulaşma açısından bir eşitsizlik var. Afrika'nın yer altı kaynakları vardır belki petroleri de vardır. Ama onlar onu çıkartamıyorlar. Çünkü gelişmiş değiller. Ama

Avrupa gelişmiş olduğu için Afrikadaki kaynağı gelişmiş Avrupa ülkeleri kullanıyor. Ekonomik şeylerle de ilgili tabi bu. Ekonomik anlamda öndeyseniz teknoloji sizde bir şekilde ileride oluyor. O teknolojiyi üretmek için de, devam ettirmek için de enerji ihtiyacı oluyor elbet. Dolayısıyla da Afrika gibi gelişmemiş ülkeler, yani ekonomileri de gelişmediği için, teknolojisi de ileri olmadığı için enerjiyi de o kadar efficient kullanamıyor. (PST3)

“There is an inequality in reaching energy. Africa has underground resources, perhaps oil. However, they cannot mine their resources because this country is not developed. However, since Europe is developed, the source in Africa is used by European countries. It is also related to economic things. If you are predominant in the economic sense, the technology is improved. Certainly, in order to produce and sustain that technology, energy is required. Therefore, since the economy of countries like Africa is not developed and the technology in these countries is not advanced, energy cannot be used efficiently.” (PST3)

- Enerjiyi dışardan alıyoruz bildiğim kadarıyla, çok yüksek, çok büyük bi kısmını diye biliyorum. (PST6)

“As far as I know, we import energy from foreign countries. As I know, the amount is very high.” (PST6)

- Avrupa ülkelerini düşünün devlete karşı kendi tepkilerini gösterebiliyorlar, hani bunu istemiyorum yani yenilenebilir enerji kaynağı istiyoruz, zarar verilmesini istemiyoruz diye bu tür şeylere diye aslında tepki gösteriyorlar. Söylemek istediğim, tepkilerini gösterebiliyorlar. Burda Türkiyede farklı işliyor. Mesela, nükleer enerji kurulacak ama orda yaşayan insanlara sorulmadan, onayları alınmadan yapılmak isteniyor. (PST2)

“People in European countries can show their reaction to the government. They can say that they do not want that kind of energy; they want renewable energy and do not want to harm the environment. That’s what I want to tell; they can express their reaction. In Turkey, it works differently. For example, it is intended to construct a

nuclear power plant without asking the opinion of people living there and without their approval for this plant” (PST2)

- “Bu kaçak elektrik kullanımı çok büyük bir mesele, çok fazla kullanan var ve bunu gerçekten hor kullanıyorlar.” (PST13)

“Fugitive electricity use is a very big problem since a lot of people use it extensively.” (PST13)

- “Mesela doğalgaz enerjisi kullanıyoruz ısınma için. Kaçak elektrik kullanımından dolayı da özellikle çok büyük paralar ödüyoruz enerji için. Aylık her aileden 500-600 lira civarında ortalama bir evden çıkan enerji gideri.” (PST11)

“For instance, we use natural gas energy for heating. We especially pay very large amounts of money for electricity due to illegal electricity use. Average energy bill for a family is between 500-600 TL.” (PST11)

- “Nüfus da gittikçe çoğaldığı için enerji ihtiyacı da artıyor aynı oranda. Çünkü insan nüfusu arttıkça yeni evler falan dikiliyor, o evleri oluşturmak için enerji gerekiyor. İşte o evde yaşamak için enerji gerekiyor. Bu da bence bir sorun.” (PST3)

“The population is increasing, so is the need for energy. Because as human population increases, new houses are being built, and energy is needed to build those houses. Besides, energy is needed to live in that house. I think this is a problem.” (PST3)

- “Ne yazık ki, ailem ekstra şeyler satın almayı çok seviyor. Örneğin, daha fazla yemek koymak için ekstra buzdolabı alıyorlar. Onlara gerekli olmadığını söyledim ama dinlemiyorlar çünkü enerji nedir, nasıl üretildiğini, enerji kaynaklarının ne olduğunu bilmiyorlar. Bunların farkında değiller.” (PST2)

“Unfortunately, my family loves buying extra things. For example, they buy extra refrigerator to put more meal. I tell them it is not necessary but they do not listen because they do not know what energy is, how it is generated, what the energy sources are. They are not aware of things like these.” (PST2)

- “Fosil yakıtlarının sonunun gelme ihtimali çok yüksek ve işte bu fosil yakıtlarının tekrar elde edilebilmesi için de çok uzun bir zaman dilimine ihtiyacımız var. Eğer biz bunu kadar istismar etmeye devam edersek bir gün biticektir.” (PST8)

“It is very likely that the fossil fuels will be finish and we need a very long time period to get these fossil fuels again. If we continue exploiting them, they will finish one day.” (PST8)

- Karbondioksit salınımı bir problem, çünkü küresel ısınmaya ve iklim değişimine sebep oluyor. Öyle olunca, dediğim gibi hani iklimler şaşıyor yani. Bir de bu sadece sıcaklığa, kuraklığa doğru değil, iklim anormalleşiyor. Böyle olunca sel, fırtına gibi, yani şu an ki durumumuzu ben, ona bağlıyorum. Yazın ortasında deli gibi yağmur yağıyor, kar yağıyor. Hani bunların nedenini ben, ona bağlıyorum. Karbondioksit salınımı, iklim değişimi, ben, buna bağlıyorum. (PST4)

“Carbon dioxide emission is a problem since it causes global warming and climate change. Then, unusual things happen in climate. It is not only about the temperature increase or about drought, the climate is getting abnormal. Floods and storms also occur. I relate our current situation to this problem. For example, it rains heavily in the middle of summer or it snows unexpectedly. I think carbon dioxide emissions and climate change lead to these changes.” (PST4)

- “İklim değişikliğinden dolayı buzullar eriyor ve su seviyesi yükseliyor. Bu sebeple, deniz kıyısında yaşayan insanlar başka yerlere göç etmek zorunda kalacak....İklim değişikliğinden kaynaklı insanlar, göç ettikçe işlerini kaybedebilirler. Tarım arazileri olanlar, orayı terk etmek zorunda kalabilirler ve işsiz kalabilirler... Sonra, yiyecek ve alan sınırlı olduğundan insanlar birbiriyle rekabete bile girebilirler. Belki çok hayalperest bir senaryo ama belki bu göçlerden dolayı, iklim değişikliğinden kaynaklanan göçlerden dolayı, sınırlı kaynaklardan dolayı insanlar birbirlerini öldürmek zorunda bile kalacak belki. Savaş bile çıkabilir.” (PST4)

“Because of the climate change, glaciers are melting and the level of water is increasing. For that reason, people living on the coast will have to migrate....When they have to migrate, they lose their jobs. Maybe they have to leave their agriculture lands and lose their jobs...Then, people may enter a competition when the space and food are limited. Maybe this is a utopic scenario, but maybe because of climate change migrations, people will even kill each other for limited resources. Even a war will start. (PST4)

- “Diğer ülkelere göre bizim ülkemizde gerçekten çok pahalı. Hatta ülkeyi geçin bazen ilden ile bile fark ediyor petrol, benzin fiyatları vs. O yüzden hani genelde de zaten duyuyoruz, yabancı ülkelerde ne bileyim 1 liraya alırken biz 5 liraya, 8 liraya, 10 liraya alıyoruz yani çok fazla fark var.” (PST17)

“The cost of oil is really expensive [in our country] compared to other countries. In fact, the prices show a variation between cities. Anyway, for example, we hear that while the citizens in foreign countries buy oil for 1 Turkish Lira, we buy it for 5 or even 10 Turkish Liras. I mean there is really a major difference.” (PST17)

- “Bizim ülkemiz 3 tarafı denizlerle çevrili, sürekli 4 mevsimi gören bir ülke. Fakat biz güneşten fazla yararlanamıyoruz mesela.” (PST23)

“Three sides of our country is surrounded by sea, and four seasons is lived in our country. However, we do not get much benefit from the sun.” (PST23)

- “Yenilenebilir enerji kaynaklarından enerji üretmek için de bir miktar enerji tüketilmektedir. Örneğin, güneş panelleri. Süreçte hangi malzemelerin kullanıldığını tam olarak bilmiyorum ancak güneş panelleri üretmek için bu materyallerin üretilmesi gerekiyor; Belki bazı kimyasal işlemler vardır. Yani bu süreçte enerji kullanımı var ve bu malzemeleri üreten fabrika fosil yakıtlar kullanıyorsa, doğaya zarar veriyordur.” (PST2)

“In order to generate energy from renewable energy resources, some amount of energy is used. For example, solar panels. I do not know exactly what materials are used in the process but in order to produce solar panels, these materials have to be produced; maybe there are some chemical process. I mean, if the plant produces these materials with fossil fuels, it harms the nature.” (PST2)

- “Yenilenebilir enerji kaynakları da genel anlamda maliyeti yüksek olduğu için sanırım herkes [tüm ülkeler] için problem. Bence genel sorun şu anda budur, çünkü çok fazla yenilenebilir enerji imkanı varken ama hani maliyetinden, uzun vadede [enerji şirketleri için] çok bir kârın olmaması gibi hesaplar üzerinden çok tercih edilmiyor gibi.” (PST1)

“I think it is a problem for everyone [all countries] because renewable energy sources are generally cost much... I think the general problem is that there is a lot of renewable energy available but it is not preferred due to the high cost and not profitable over the long term [for energy companies]” (PST1)

- “Şimdi ilk başta sürekli yapım aşamasını falan bayağı gördüm ben hani sürekli yollar falan bozuluyodu zaten, kocaman kocaman kamyonlar geçiyodu hep, hava kirliliği falan oluyodu. O şekilde bir sürü ağaçlar falan gitti o süreçte onları gördüm. HES yapıldıktan sonra her şey normal gibiydi 1-2 yıla suyun bayağı bi daraldığını gözlemledim. O dereler bayağı normal gürül gürül akarken bayağı az akmaya başladı... Hani o dereden mesela karşıdan karşıya yürüyerek geçemeyecek olduğumuz derinlikteydi mesela şu an normal dümdüz yürüyebiliriz, taşların üstüne basarak ıslanmadan bile geçebiliriz yani o kadar gür değil.” (PST10)

“I saw the construction phase of the hydroelectric power plant. The roads are broken, huge trucks were working, and air pollution was happening. A lot of tree was cut at this stage... Then after its installation, everything seems normal firstly but in one or two years, I observed that the flow rates of rivers lower. However, these rivers used to flow fast...It was very difficult to pass over these rivers by walking because they were

deep but now they are as shallow as that you can pass the river without getting wet. I mean they are not flowing copiously” (PST10)

- “Baraj geldikten sonra oluşan iklim değişikliğinden dolayı bazı bitkiler doğru düzgün yetişmemeye başladı. Mesela üzüm, üzüm sıcaklığı çok sever, üzümlerimiz artık olmamaya başladı. Çünkü yazın nemli ve yağmurlu bir havamız var. Yağmuru sevmez, üzüm kesinlikle güneşi sever, öyle bir bitki. Böyle bir zararı var bence bitki örtüsüne... Balıkların hepsi göç etti. Doğal yaşam alanlarını tamamen terk ettiler.” (PST5)

“Due to the climate change that occurred after the dam, some troubles have arisen among plants. For example, grapes. Grapes, as a plant, love hot weather. Our grapes are not growing properly anymore. Because we have a humid and rainy atmosphere in summer now. This plant does not like rain, grapes certainly likes the sun. I think there is such an impact on plant cover.... All fish immigrated and they left their natural habitat.” (PST5)

- “Çine Çayı çok eski tarihi bir yer bizim orada. ince kemer falan vardı. HES kurulduktan sonra su gittikçe artınca o dediğim eski köprüler falan sular altında kaldı ve tarihi şeyler gitti yani, çok üzücü... Çok aşırı nem yaşıyoruz hani yaş, yani tıkiyo insanı nefes almakta zorlanıyoruz. Mesela annem astım bronşiti hastası o nem mesela onu tıkiyo hani rahatsız oluyo o nemden, rahat edemiyor. Bu nem de HES nedeniyle arttı.” (PST9)

“Çine stream is located on a historical place in my hometown. There was a tied-arch bridge. After the construction of hydroelectric power plant in that area, the water level increased gradually and ancient bridge was flooded. Everything is gone, it is very sad.... We are experiencing extreme humidity and it makes difficult to breath. My mum has asthma bronchitis and that humidity makes her uncomfortable. This humidity is also increased because of the hydroelectric power plant” (PST9)

- “HES’in kurulması demek yine çiftçilerin su kaynağını şey yapmaları demektir, yani yıkmaları demektir.” (PST3)

“The establishment of hydroelectric power plants means that farmers’ water source is destroyed.” (PST3)

- “HES tarzı şeylerin bu kadar çok yoğun yapılmaması gerekiyor çünkü cidden her dereye bir tane kuruyorlar hani ne bileyim Giresun’da 10 tane dere varsa birisine kursalar hani bir yerde anlayacağım ama 10’una da kuruyorlar.” (PST10)

“Hydroelectric power plants should not be established intensely. For example, if there are ten rivers in Giresun, they build hydroelectric power plants on each river. I can understand the reason when they build one but they construct it on each of river.” (PST10)

- “Köylüler inekleri otlatamamalarından şikâyet ediyorlardı. Rüzgâr enerjisi geldikten sonra etraftaki çimenlerin yoğunluğu azaldı. İşte koyunlarımız, ineklerimiz o tarafa yaklaşmıyor diyorlardı. Bu tarzda bir kaygıları vardı.” (PST10)

“The villagers complained about that they could not graze their cows since the amount of grass decreased around the wind power. Furthermore, they told that their cows did not want to go around the wind power. The villagers had this kind of concerns” (PST10)

- “İzmir’deydi sanırım rüzgâr enerjisi vardı bi köyün, dağın tepesinde falan mesela ordaki insanlar da sürekli gürültüsünden şikayet ediyorlardı.” (PST9)

“As I remembered it was in Izmir. The villagers complained about the constant voice of the wind power in their village” (PST9)

- “Dalga enerjisinde belki hani balıkların yoğun yaşadığı yerlere kurulursa problem yaratabilir, onların yaşam alanını etkileyebilir.” (PST1)

“Wave energy may cause some problems if they installed in which fish population is intense. It may affect their living area.” (PST1)

- “Nükleer enerji santralinden verilen sıcak su, mesela muhtemelen oradaki canlıların yaşam alanını değiştirecektir ve belki de pek çoğu ölecektir.” (PST1)

“Due to the hot water released from nuclear energy power plant can change the environment of aquatic animals and perhaps many of them will die.” (PST1)

- “Gerçekten hani kârlı bir yatırım mı olacak [nükleer enerji santrali], yoksa başka bir şey için mi yapılıyor bence bu da bir sorun.” (PST3)

“Is it [nuclear energy power plant] really a profitable investment or is it done for something else? I think it is a problem too” (PST3)

- “Bir radyasyon alanı olacak sonuçta [nükleer enerji santralinin etrafında], hani çevredeki yaşayan birçok insan zarar görecek mesela. Bu açıdan biraz kaygılarım var. Çernobil kazasından dolayı Karadeniz bayağı bi zarar görmüştü. Ben o yılları bilmiyorum tabi de o zamanlarda yoktum annem bahsediyodu mesela o yıl çay içmemişiz biz hiç demişti çaylarımızın üzeri bembeyaz olmuştu zaten birçok kanser vakası oluyo o zamanın çocuklarından veya ne bileyim ondan sonraki olan çocuklardan bayağı bi hâlâ radyasyonun etkisi var hani onun bile etkisi yıllardır devam ediyor.” (PST10)

“There will be a radiation field or something [around the nuclear energy power plant], and many people living in the environment will be harmed. I have such concerns like this.... Because of Chernobyl accident, the Black Sea region was affected from the consequences a lot. I was not born yet when the accident was happened but my mum

told about it. She told that all tealeaves were covered with white and they did not drink tea in that year. Because of the accident, the cancer rate is increased. For example, many children born in that year and after that year caught cancer. The effect of radiation is still continuing for years.” (PST10)

- “Bir nükleer enerji santralinin ömrü bildiğim kadarıyla 60 sene falan, 60 seneden sonra kesinlikle işletilmemesi gerekiyor. Şimdi hepsini ortaya dökcek olursak, enerji santralinin kurulumu var, bunun işletilme süresindeki vereceği zararlar var, bu kapatıldıktan sonra ne yapılacağı var. İşletim sırasındaki olaya şey diyorlar, bizim kullanacağımız enerji santrali son model olacak, bilmem ne özellikleri sızıntı kesinlikle yapmıyor vesaire. Toplum olarak biz bunu gerçekten yönetebilecek miyiz; birincisi. Biz yönetemiyoruz ki bunu zaten gidip yabancı bir şirkete verdik, bir Ruslara verdik. Biz bu donanıma sahip değiliz. O adamlar o işi yaparken biz aslında hiçbir şeyin farkında olmayacağız, biz sadece kabloyu takıp tamam santral bize enerjiyi veriyor ama, o santralin içinde ne oluyor gerçekten, biz bunun farkında olmayacağız bence. Çünkü biz yönetmiyoruz orayı.” (PST5)

“As I know, life time of a nuclear power plant is 60 years or so, after 60 years it must never be operated. There is an installation process of the power plant, during the operation process there is damage to environment, and what to do after it is closed. It is told [about Akkuyu nuclear power plant] that the last technology will be used and such features of it certainly prevent any leak and etc. However, as a society, can we really manage this? First, we do not manage the plant. Its management is already given to a foreign company; we gave it to Russians. We do not have the control over the operation. When those guys are managing that we will not actually be aware of anything, we just plug in the cable and the power plant gives us energy, but I think we will not be aware of what happens in that plant. Because we do not manage it.” (PST5)

- “Biz enerjiyi boşa harcıyoruz. Evlerde bile kimsenin enerji tasarrufu yaptığını sanmıyorum. Sabahtan akşama kadar o elektrik yanıyor. Sabah ışığını, güneş ışığını

kullanmaktansa o elektrik enerjisini kullanıyoruz, o enerjiyi boşa harcamış oluyoruz sonuçta. O da ileride büyük bir sıkıntı çekeceğimizi düşünüyorum bu açıdan.” (PST25)

“We are wasting too much energy. In fact, I do not think people save energy at homes. Electricity is being used from morning to night in vain. Instead of using sunlight during daytime, electricity is used. As a result, it is wasted in vain. In this respect, we will live serious energy problems in the future.” (PST25)

- “Genel olarak zaten tüketim toplumuyuz ve düşününce işin ucu yine enerji kaynaklarına gidiyor. Mesela, çay içiyoruz, bu çay üretilirken bile bir sürü enerji harcanıyor, enerji kullanıyor ya da bir şeyleri israf ettiğimizde bile şeyi düşünmemiz lazım, bu üretilirken örneğin en basitinden ekmek diyelim, bu üretilirken enerji harcanıyor. Onun için düşünmeden tüketiyoruz bir şeyleri. Aynı şekilde kaynakları da düşünmeden tüketiyoruz. Eskiden bu kadar çok kıyafet yoktu ama, insanlar yine de mutluydu. Şimdi bir sürü kıyafet vara, ama mutsuzlar. Üretim artıyor, insanların doğru orantılı olarak mutsuzluğu da artıyor bence.” (PST3)

“We are a consumerist society and in my opinion, this is rooted in energy resources. For example, while tea is produced, energy is consumed and when we waste tea, we actually waste energy. Or breads, when breads are produced, energy is consumed. Therefore, we consume without thinking. Likewise, we consume resources carelessly. There were not so many clothes in the past, but people were still happy. Now there are many clothes, but people are unhappy. I think people’s misery is increasing in direct proportion to increase in consumption.” (PST3)

- “Enerji kullanımı konusunda bilinçsiziz. Örneğin, Ankara’da gereksiz olmasına rağmen klima satın alıyoruz. Evlerinde iki klima olan akrabam var. Bu gerçekten gereksiz. Biz millet olarak israfı seviyoruz. Aslında, millet olarak, gelecekte ne yaşanacağını ve gelecek kuşaklara ne bırakacağımızı düşünmüyoruz. Bu bilinçli olmakla ilgili bir mesele.”(PST2)

“We are unconscious about use of energy. For example, we buy air conditioning, although it is unnecessary in Ankara. I have a relative having two air conditioning in their home. It is not necessary indeed. We like wasting as a nation. In fact, as a nation we do not think what would happen next, what we leave to future generations. It is related to being unconscious” (PST2)

- “Bence iklim değişikliğini etkilemez. Düşünüyorum... Bir zamanlar taşkömürü kullanıyorduk diyelim ısınmak için, şimdi doğalgaza geçtik. Değiştirdik ama yani daha temiz bir çevre oldu ama bunun iklimi değiştirdiğini düşünmüyorum. Bence etkilemiyor.” (PST14)

“I think it does not affect climate change. I am thinking...We used to use coal for heating at houses but we use natural gas now and we have cleaner air and environment but I do not think this affect climate change. I think there is no relationship.” (PST14)

- “Şu an bir iklim değişikliği olduğunu düşünüyorum... Bu, enerji kullanımıyla alakalı olabilir çünkü biz doğaya zarar veriyoruz.... Mesela şimdi ın santraller vesaire var ya bunların, en azından bunların kurulduğu yerlere bakarsak doğayı tahrip ediyolar... Bu santralleri kurmak için ağaçlar kesiliyor, orda yaşayan hayvanlar var yani direkt olarak doğaya zarar veriliyor.”(PST12)

“I think there is a change in climate...This may be related with energy use since we cause harm to nature...For example, there are energy generation plants and if we look the construction areas of these plants, they destroy the environment...In order to construct a plant trees are cut and animals living in that are affected and there is a direct harm on environment.” (PST12)

- “Enerji kullanımıyla iklim değişikliğinin ilişkili olduğunu düşünüyorum. Karbon salınımının iklim değişikliğini etkileyebilir. Çevreye nihayetinde olumsuz bir salınım oluyor, bu olumsuz salınımdan da çevrede yaşayan her şey etkileniyor, etkilenmesi sonucunda da değişiklikler olabilir diye düşünüyorum.... Enerji tasarrufuyla iklim

değişikliği de ilişkilidir. Yani, çok fazla tasarruf yaparsak bu çevrenin olumsuz etkilenmesini azaltabiliriz.” (PST17)

“I think energy use and climate change are related. Carbon emissions can influence climate change, I think. There is a negative release into the environment, this can affect the environment, and because of this, some changes can happen...Energy conservation and climate change are related. That is, we can decrease the negative influences on environment if we conserve more energy” (PST17)

- “Fosil yakıtlardan enerji üretirken, bu süreçte çıkan gazlar iklim değişikliğine neden olur ve doğaya zarar verir. Örneğin, CO₂ ve termik santralden çıkan diğer zararlı gazlar nedeniyle ısı dünyada daha uzun süre kalıyor ve bu gazlar küresel ısınmaya neden oluyor. Bu küresel ısınmaya bağlı olarak kuraklık görülebilir veya yağış yoğunluğu daha da düşebilir veya yağış süresi değişebilir. Ayrıca, enerji kullanımı açısından, enerji talebi, gereksiz enerji kullanımı nedeniyle artabilir. Bu nedenle, enerji üretme ihtiyacı artar ve atmosferde daha önce bahsettiğim gaz yoğunluğu artar. Enerjiden tasarruf edersek, iklim değişikliğini azaltabiliriz. Örneğin, elektrikli cihazları kullanmadığımız zaman kapattığımızda enerjiden tasarruf ediyoruz ve enerji talebinin azaltılmasına yardımcı oluyoruz. Bu şekilde, santrallerde kullanılan fosil yakıtların kullanımını azaltabiliriz. Bu şekilde zararlı gazlar azaltılabilir ve CO₂'nin ve diğer gazların iklim değişikliği üzerindeki zararlı etkisini azaltabiliriz.” (PST1)

“While generating energy from fossil fuels, the gases revealed from this process cause global warming and gives harm to nature. For example, due to CO₂ and the other harmful gases revealed from thermal power plant, the heat stays longer at earth and these gases global warming. Depending on this global warming, droughts can be seen or the rainfall intensity can be getting lower or the time period for rainfall can be changed. Furthermore, in terms of energy use, energy demand can be increased due to unnecessary energy use. Therefore, the need for generating energy is increased and the density of gases I mentioned before were increased in the atmosphere. If we save energy, we can decrease climate change. For example, when we turn off electrical

devices when we do not use them, we save energy and we help decrease the energy demand. In this way, we can decrease the use of fossil fuels used in power plants. In this way, the harmful gases can be decreased and we can decrease the effect of CO₂ and the other gases harmful effect on climate change.” (PST1)

- “Enerjiyle iklim arasında... Şöyle, Çernobil patlamasını örnek verebilirim. hani Çernobil’de orada büyük bir değişiklik yarattı patlama sonucunda. Orada iklim çok değişti, hani eskisi gibi değildi, hatta şu an bile devam ettiği söyleniyor. Ağaçlar, ormanların hala kimyasal maddelerin etkisi altında. Yani enerjiyi doğru kullanamazsak iklimimizin gerçekten etkilendiğini düşünüyorum.” (PST19)

“Energy and climate change... I can give the example of Chernobyl explosion, which caused great changes there. The climate changes there and its effects are still said to be continuing. The trees and the forests are still under the influence of chemical matters. If we do not use energy properly, it influences our climate.” (PST19)

- “Enerji ve iklim değişikliği arasında bir ilişki olabilir. Tükettiğimiz enerji miktarı iklim değişikliğinin hızını ayarlayabilir. Mesela bizim çok fazla enerji kullanmamız, işte enerjiyi heba etmemiz, işte küresel ısınmaya bundan 100 yıl önce değil de şimdi gidecektir. Sadece bunları hızlandırabilir. Böyle bir ilişki kurabiliriz yani... Aslında evren, oluşumundan beri çok düzensiz, muhteşem bir kaos var ortada, hani hiçbir düzen yok. Çünkü 500 bin yıl önce bir buzul çağındaydı dünya değil mi? Çok ciddi bir buzul çağı, yani Karadeniz topraklarına kadar buzulla kaplıydı. Bunun sonrasında çok ciddi miktarlarda ısı artışı oluşmuştu... Aslında dünya sürekli düzensiz bir yapıda; küresel ısınma aslında insanlar da bunu tetiklemiş olabilirler. Yani tamamen neden değil de sadece bir etken olabilir, hani sadece bir adım olabilir, itekleyen bir sebep olabilir. Yani bu doğal süreçtir. Doğal süreç, evet... İnsanların tam anlamıyla nedeni değil ama sadece küçük bir nedeni ya da etkeni diyebiliriz ona... Enerji kullandığımızda atmosfere CO₂ gazı salınır. CO₂, ısıyı atmosferde tutan çok etkili bir ısı tutucudur. Ve karbondioksiti biz ciddi miktarlarda dünyadan atmosfere salınım

yapıyoruz. Yani petrolün aşırı miktarda kullanılması ya da fazla enerji kullanımı, büyük miktarda CO₂ emisyonu ile sonuçlanır ve dolayısıyla küresel ısınmayı dolaylı olarak etkiler. Söylediğim gibi bu sadece bir tetikleyici ... Enerji kullanarak iklimi değiştireceğimizi sanmıyorum. Enerjiden tasarruf edersek, zaten doğada olan şeyi kullanmamış oluyoruz sadece... Enerji tasarrufu yaptığımız zaman, doğanın kendisini yenilemesine yardımcı olmuyoruz. Biz enerji tasarrufu yapsak da yapmasak da doğa yine doğa olarak kalır.” (PST11)

“There may be a relationship between energy and climate change. The amount of energy we consume can adjust the speed of climate change. For example, if we use too much energy, I mean if we waste too much, it will cause global warming 100 years. Energy waste can accelerate things. There may be such a relationship between energy use and climate change... In fact, since the formation of universe, there is a magnificent chaos and nothing is regular. Because our world was in the glacial period about 500 thousand years ago. Everywhere was covered with ice up to the Black sea land...After this period, the world entered the warming phase...In deed, the world is unstable. That is, people may trigger the global warming but I do not think they are the main factor. Their effect may be a step or a trigger. I mean this is a natural process and people’s activities are not the major factor... When we use energy, CO₂ gas is released into the atmosphere. CO₂ is a very effective heat-trap, which keeps the heat in the atmosphere. We released great amount of CO₂ into the atmosphere from earth. I mean too much use of petroleum or too much use of energy is resulted in great amount of CO₂ emissions and this affect the global warming indirectly. Just I told, it is only a trigger.... I do not think we can change the climate with using energy. When we save energy, we do not use the thing, which is already in nature... When we conserve energy, it would not help to heal nature. Whether we save energy or not, it will stay as nature.” (PST11)

- “Bildiğim kadarıyla, beş ya da altı yıl önce, Alman hükümeti, vatandaşlarını daha az karbon emisyonu olan otomobilleri kullanma konusunda kredilerle teşvik etti. Bunu Almanya'da yaşayan kardeşim var ondan biliyorum. Yani, bu araçların üretimi

yaygınlaşırsa ve eğer hükümet insanları desteklerse, bu durum petrol kullanımını azaltabilir” (PST2)

“As I know, five or six years ago, German government encouraged the citizens through credits to use automobiles having less carbon emissions. I know this from my brother living in German. I mean that if the productions of these tools are spread and if the government support people, the use of petroleum can be decreased” (PST2)

- “Bu nükleer enerji problemi ideal ortamda bence çözülebilir. Bilim insanları gelir, o yönetenler, ve yerel halk gelir, bir eđarisi doğrusu konuşulur, bunun üzerinde tartışılır ve bir karara ulaşabilirler.” (PST3)

“I think this nuclear energy problem can be solved in an ideal environment. For example, scientists, politicians and local people come together; discuss the issue, and then they can arrive at a decision.” (PST3)

- “Enerji üretmek zorundayız. Alternatif enerji kaynakları üzerinde düşünmediğimiz sürece, fosil yakıtlara bağımlı kalacağız ve onlar da negatif sonuçlara yol açacak.” (PST2)

“We have to produce energy. As long as we do not think on alternative solutions, we will have to be dependent on fossil fuels and it will lead negative consequences.” (PST2)

- “Teknoloji de hızla arttığı için bence umut var, enerji üretimiyle ilgili.” (PST7)

“Since the technology is advancing rapidly, there is a hope for energy production” (PST7)

- “HES kurmaktansa nükleer santral kurmaktansa güneş enerjisine yönelmeliyiz.” (PST10)

“Instead of constructing hydroelectric power and nuclear energy power plants, we should tend towards sun power.” (PST10)

- “[Hidroelektrik santral] Benim için yenilenebilir değil. Kurulduğu zaman oradaki mesela dereye su verilmiyor ve oradaki canlılar etkileniyor. Tarım yapan insanımızın geçim kaynağını da olumsuz etkiliyor. Bu insanın yaşam alanını etkiliyorsa, canlıların yaşam alanını etkiliyorsa bence yenilenebilir değildir.” (PST1)

“It [Hydroelectric power plant] is not renewable for me. When it is constructed, water is not released to the river and creatures living there are affected. The livelihoods of farmers are affected negatively as well. If it affects the livelihoods of people and the living area of animals and plants, it is not renewable for me.” (PST1)

- “Enerji başlı başına bir problem Türkiyede ve bence hidroelektrik santraller daha fazla kurulmalı.” (PST20)

“Energy is already a problem in Turkey and I think that hydroelectric power plants should be built more.” (PST20)

- “Türkiye'deki her bölgenin kendine has bir iklimi ve coğrafi özellikleri var. Bunu düşünerek yani her bölgenin özelliklerini göz önüne alarak, en uygun yenilenebilir enerji türü kullanılabilir. Örneğin, uzun süre güneş alan bölgelerde güneş enerjisi kullanılabilir, rüzgâr potansiyeline sahip bölgelerde rüzgâr enerjisi kullanılabilir.” (PST2)

“Each region in Turkey has their specific climate and geographical properties. By considering the features of each region, the most appropriate renewable energy type

should be used. For example, regions with having long sunny duration should use sun power, regions having wind potential should use wind energy.” (PST2)

- “Ulusal olarak nükleer enerjiye bir adım attık. Ben aslında savunuyorum nükleer enerjiyi çünkü o santralde muazzam miktarda enerji üretilebilir... Bu enerji ihtiyacımızı çok daha rahatça kolayca karşılayabiliriz. Tehlikeleri var ama bunun önlemleri de var, önlemleri de olabilir. Ben ona karşı değilim, nükleer enerji kurulabilir.” (PST11)

“Nationally, we took a step to construct a nuclear energy power plant. I am actually a supporter of it because in that plant, enormous amounts of energy will be generated... We can easily meet the energy need with this plant easily. There are hazards, but there are precautions as well. I am not against it; nuclear power can be established.” (PST11)

- “Geçenlerde bir belgesel izlemiştim, Fransa’da yeni inşa edilen bir nükleer enerji santrali hakkında. İleri bir teknoloji kullanmışlar ve herhangi bir sızıntıda dahi dışarıya sızmayacak şekilde tüm tedbirleri almışlar... Fransa’nın önemli enerji ihtiyacını karşılayacakmış. Her türlü ihtimal düşünülüp en küçük ihtimal dahi değerlendirilip hepsini simülasyon üzerinden düşünmüşler ve tüm hesaplamalar planlama aşamasında yapılmış... Buradakine tüm bu detaylar ve planlama bu şeklide düşünülmüş mü bilmiyorum. Ama riskler en azından bu şekilde planlama ile düşürülebilir.” (PST1)

“I watched a documentary on a nuclear power plant, which is being constructed in France. An advance technology is being used in the plant and they have taken all precautions against radioactive leak.... It will contribute significantly to meeting the energy demand of France. Each possible scenario was thought and simulations and calculations were all considered during the planning phase... I do not know if the details and planning were thought like this documentary in here... But the risks can be decreased with planning in this way at least.” (PST1)

- “Cidden dışarıya olan enerji bağımlılığımızı bitirecek, ya da halk bundan yararlanabilecek mi mesela? Halkın diyelim 200 lira elektrik faturası geliyorsa bu 150’ye mesela inecek mi? Madem bu kadar kuruyoruz, para harcıyoruz en azından hani bunun faydasını halk bir yerden görmeli bence. En azından onu görürsek de bari bir şeyler oldu, bir işe yarıyor bunu diyebilecek yapıda olalım. Ama hani onu kurduk, hiçbir faturada değişiklik yok, zamlara devam, hiçbir insana, halka katkısı yoksa çok da mantığı kalmadı. Dahası, bu tesise en yakın yerleşim yeri sürekli tehdit altında olacak. Risk üstüne risk artmış olur, yani hiçbir faydası da olmamış olur.” (PST1)

“Will our dependency to foreign energy sources be end or will people benefit from them [nuclear energy power plants]? For example, will an electricity bill of 200TL be 150TL? Now that we construct these power plants and huge amounts of money are spent. In the end, people should benefit from this plant somehow. At least we should see something. If everything remains the same, the bills increase then there is no logic in this. Furthermore, the nearest settlements to the plant will be in constant threat. The risk increases without any benefit.” (PST1)

- “Mesela artık buzdolaplarında bile a plus plus diye geçiyor, daha az enerji harcıyor, elektriği çok az harcıyor veya ne bileyim led ışıklar çıktı bu şekilde ampul daha az yakıyor. Bunların hepsi enerji tasarrufu sağlıyor.” (PST10)

“For instance, refrigerators with A plus, which consume less energy are available now. LED lamps are also consuming less energy. They all contribute to energy conservation.” (PST10)

- “Enerjinin Gereksiz kullanımından kaçınmamız gerekiyor. Bunun için halkın bilinçlendirilmesi lazım, eğitimin bu şekilde verilmesi gerekiyor. Çocuklara bu şekilde eğitim verilip halk enerji tasarrufu hakkında daha bilinçli hale gelebilir.” (PST5)

“We need to avoid unnecessary use of energy. For this end, the public should be educated. Children should be educated in this way, and the public will be more aware about energy conservation.” (PST5)

- “[Enerji politikaları ile ilgili kararlar alınırken] Bence ekonomik odaklı değil de, doğa ve insan sağlığı odaklı düşünülmesi gerekiyor, gelecek nesilleri düşünmemiz gerekiyor.” (PST3)

“[While taking decisions about energy policies] nature and human health centered decisions should be taken rather than economic centered. I think we should consider the future generations in these issues.” (PST3)

- “Benim için önemli, Yani, hayat felsefem diyebilirim. Anlık bir davranış değildir öyle diyim. Her zaman enerji tasarrufu yaparım. Hayatımın bir parçası olmuş durumda.” (PST1)

“It is important for me. That is, it is my life philosophy. It is not an instant behavior; I always conserve energy. It is a part of my life.” (PST1)

- “Enerji tasarrufu yaptığımda daha duyarlı hissediyorum ben kendimi, daha iyi hissediyorum. Bunun konuşulması, bilinçli bi birey gibi hissetmek buna itiyor biraz da.” (PST6)

“When I do it, I feel more responsible and feeling in this way makes me feel better. When I display these behaviors and when we talk about these issues, I feel myself sensible.” (PST6)

- “Benim için alışkanlık değil. Mesela küçüklükten beri bu şekilde alışsak aslında yaparım. Ama alışmadım, yapmıyorum, çevresel etkenler zaten çok fazla. Sürekli bir koşuşturma, bir telaş içindeyiz zaten... Unutup gidiyor insan mesela o ışığı en basit

örneğiyle söndürmeyi ihmal ediyorum ya da o kağıdı direkt çöpe atıyorum geri dönüşüm yerine. O enerjiyi o şekilde tasarruf yapmıyorum yani.” (PST25)

“It is just not a habit for me. If I acquired this habit since my childhood, I would conserve energy. But I'm not used to it, I do not save energy. Environmental distractors are already too much. We're in a constant hustle and bustle. Therefore, I forget it. For example, that light is the simplest example. I ignore turning light off or I throw away the paper instead of recycling. Indeed, I do not save energy.” (PST25)

- “Enerji tasarrufu yapmak benim için önemli, çünkü enerji ve su olmadan ne yapacağımızı düşünüyorum. Şu an bir enerji krizi yaşayamıyor olabiliriz, ama gelecek kuşaklar ile ilgili ve onların geleceği ile ilgili kaygılanıyorum, enerji tasarrufu yapmanın önemli olduğunu düşünüyorum.” (PST2)

“Saving energy is important for me because I think what we would do without energy and water. We may not live an energy crisis but I think about next generations and for their future, saving energy is crucial for me.” (PST2)

- “Aslında ne yapabileceğimi çok fazla bilmiyorum. O da söylenebilir.” (PST22)

“In fact, I do not know what to do for saving energy.” (PST22)

- “Barajların etkileri ile ilgili bir belgeseldi. Bir Afrika ülkesiydi galiba, su seviyesi o kadar çok artmıştı ki maymunlar bile batmak üzereydi. Bir ağaçtaki maymun batmak üzereydi ve çaresiz haldeydi. Hayvanlar helikopterlerle taşındı ve kurtarıldı. Tüm bunlar çok dokunaklıydı benim için. Demek istediğim, baraj inşaatının neden olduğu zararlar tek boyutlu değildir. Doğa, insan ve hayvanlar üzerinde pek çok etkisi var.” (PST2)

“It was a documentary related to the impacts of dams. I suppose it was in an African country and the level of water was increased so much that even monkeys were about

to sink. There was a monkey on a tree and it was about to sink and it was desperate. Animals were transported by helicopters and they were saved in this way. That was very touching for me. I mean the harms caused by construction of dam have not one-dimensional. It has multiple impacts to nature, people and animals.” (PST2)

- “Bir fikri ısrarla savunmak yerine, karşı tarafın fikirlerini dinlemenin ve bir değerlendirmenin önemli olduğunu öğrendik. Bu dersler sayesinde, özellikle STS dersi argumantasyonun kullanımıyla ilgili ve enerji kaynakları ile ilgili bilgi konusunda bana çok katkısı oldu.” (PST4)

“We learned that instead of insisting on an idea, listening the opponent ideas and making evaluation. Thanks to these courses, especially STS course contributed to me a lot regarding the use of argumentation and knowledge related to energy resources” (PST4)

- “Hocamızın bizim gruba verdiği ödev AŞTİ’deki bütün otobüs firmalarıyla görüşüp ne kadar atık çıktığını, günde kaç kilometre yaptıkları ve günde kaç kişiyi taşır sorularını araştırdık. En önemlisi, geri dönüşüm için ayrı bir çöp kullanıp kullanmadıklarını araştırmaktı. Araştırmada gördük ki firmalardan sadece 1’i geri dönüşüme önem veriyordu, ayrı bir çöp hazırlığı varmış, plastik için, karton için vs. için ve kendi belgeleri varmış. Sadece ondan olumlu yanıt aldık, orada belki 100-150 firmayla görüştük, bir tek ondan aldık ve insanların çevreye ne kadar çok zarar verdiğini gördük, çok fazla enerji harcandığını gördük, çok fazla karbon salınımı var. Bir firma bir günde belki 30 sefere çıkıyor, 30 seferde şimdi 45 kişiden düşüsek o çıkan çöpler zaten tonlarca, çok fazla çevreye zarar verdiğimizi gördük.” (PST17)

“Our instructor wanted from our group to investigate: how many times bus company made expedition in a day, how much garbage they produce, how many kilometers they did in one day, how many people they carried in one day? Most importantly, do they create separate garbage for recycling? Our research showed that only one bus company recycled materials. That is they used separate garbage boxes for plastic, carton, and so

on... We saw that here are many carbon emissions, maybe we visited 100 companies, and we only found one company, which recycled. We saw how much damage people cause to the environment. We spent a lot of energy. On an average, one company made 30 expedition in a day. If we think that they carry 45 people in each expedition, tons of garbage is produced each day. I really understand that we have a serious impact on the environment.” (PST17)

- “Suyun evimize gelmesi için de belirli bir enerji gerekiyor. Çünkü o suyun gelmesi için elektriğin olması gerekiyor, çünkü pompalama gibi bir sistem gerekiyor. Yani hepsi birbiriyle bağlantılı. Enerji tasarrufu için, suyu da tasarruflu kullanmalıyız.” (PST16)

“Energy is required in order to use water in our house because a pumping system, which is worked with electricity, is used for that. Therefore, all are related with each other, and we need to conserve water for energy conservation.” (PST16)

- “Özel Öğretim Yöntemleri dersinde, argümantasyon yöntemi için nükleer enerji konusu kullanılmıştı ama sınıf bir anda dağılmıştı, bir anda bir görüş ayrılıkları falan olmaya başladı, o yüzden çok fazla devam etmedik. Üstelik sınıf çok kalabalıktı. Sınıfımızdaki kişi sayısı genellikle yaklaşık 60'tı. Dolayısıyla tartışmada sorunlarımız vardı. Buna ek olarak, bu metod konusunda ne yapılacağını çok fazla anlayamadık ve bu konuyu nasıl tartışacağımızı bilmiyorduk. Arkadaşlarımız görüşlerini ısrarla savunuyor ve kendi düşüncelerimizi savunmana izin vermiyorlardı. Aslında nükleer enerji konusu, tartışmacı yöntem için çok ilginç ve çok uygundu ancak ders boyunca bunu başaramadık.” (PST17)

“In instructional method course, nuclear energy topic was used for argumentation method but the class is distracted and dissidence among groups is arisen. Therefore, we cannot continue the argumentation. Besides, the class was very crowded. The population in our class is generally around 60. Therefore, we had problems in

argumentation. In addition, we could not understand very much what to do in this method and we did not know how to discuss this topic. Our friends insist on their view and they just did not allow you to defend your own opinion. Actually the nuclear energy topic is very interesting and very proper for argumentation method but we just could not handle it during the course.” (PST17)

- “Özel Öğretim Yöntemleri-II dersinde nükleer enerji santrali üzerine araştırma yaptık ve bunu sınıfta tartıştık. Bu konuyu iki hafta boyunca tartışmıştık ve argümantasyon yöntemi kullanılmıştı. Bu tür konular sınıf arkadaşlarıyla tartışıldığında, daha etkili ve kalıcı oluyorlar... Bu ders sayesinde, nükleer enerji konusunda çok şey öğrendim.” (PST11)

“In Methods of Teaching Science-II course, we made research on nuclear energy power plant and discussed it in the class. We discussed it two weeks and argumentation method was used. When this kind of topics is discussed with classmates, they are more effective and permanent... Thanks to this course, I learned much things about nuclear energy.” (PST11)

- “Özel Öğretim Yöntemlerinde *Yeşil Kutu*dan bir gönüllü geldi, bize bu eğitim setini tanıttı. Birer CD verildi bu *Yeşil Kutu*’nun içeriğiyle ilgili. Bu çevre sorunlarıyla ilgili, enerjiyle ilgili veya sosyal sorunlarla ilgili kapsamından bahsedildi... Bunun, bu sorunların farkındalığını artırmak için yararlı bir araç olduğunu öğrendim. Enerji tasarrufu için iki veya üç ders planı olduğunu hatırlıyorum ve bunları enerji tasarrufu ile ilgili projem için incelemiştim. Öğrencilere enerji tasarrufu için poster hazırlattırıyordu veya bazı etkinlikler öneriyordu öğretmene.” (PST15)

- “In Methods of Teaching Science course, a volunteer from green box (Yeşil Kutu) came and introduced this educational set to us. They distributed a CD of it. Various environmental problems, energy problems and social problems were mentioned...I learned that it is a useful tool for raising awareness about these problems...I

remembered that there were two or three lesson plans for energy conservation and I examined them for my project related to energy conservation. It leads students to prepare a poster for energy conservation or it suggests some activities to teachers” (PST15)



APPENDIX O. TURKISH SUMMARY/ TRKE ZET

FEN BİLGİSİ ĖRET MEN ADAYLARININ ENERJİ TASARRUFU DAVRANIŞLARININ MOTİVASYON, PSİKOLOJİK İHTİYAÇLAR VE TUTUM ARACILIĞI İLE İNCELENMESİ: DAHASI FARKINDALIKLARI İLE DESTEKLENMESİ

Giriş

İnsanlığın enerjiye bağımlılığı dramatik bir şekilde artmakta ve endüstri döneminden beri enerjiyle ilgili birçok problemle karşı karşı karşıya kalınmaktadır (Muller, 2012). Örneğin, enerji üretmek için fosil yakıtlar yakıldığında, CO₂ miktarı atmosferde önemli ölçüde artmaktadır. Bu artış iklim değişikliğine yol açmakta ve bu durum çevre ve beşeri sistemler üzerinde çeşitli etkilere sahiptir. Örneğin buzulların erimesinden dolayı deniz seviyesinin yükselmesi tatlı su kaynaklarının ve lagünlerin kaybına neden olur (Parry ve diğerleri, 2007). Bir başka örnek, Meksika Körfezi'ndeki Deepwater Horizon platformunda petrol sızıntısından kaynaklanan patlamadır. Bu patlama on bir kişinin ölümüne, bölgenin etrafında yaşayan insanlara ciddi sağlık problemlerine ve deniz ekosistemine zarar vermiştir (Goldstein, Osofsky & Lichtveld, 2011). Bu temsili örnekler enerji ile ilgili pek çok problemin çevre ve toplum üzerindeki etkilerinin çok boyutlu olduğunu göstermektedir (Muller, 2012).

Hızlı artan enerji talebi karşılayabilmek için, daha fazla fosil yakıtı ihtiyaç duyulmaktadır (Goldstein ve ark., 2011). Gereksiz enerji kullanımı, bu artan talepte önemli bir rol oynamaktadır (Poortinga, Steg & Vlek, 2004). Hanehalkının enerji tüketim yüzdesi dünyada% 30, elektrik tüketimi ise enerji tüketiminde % 18 ile ikinci sırada yer almaktadır (International Energy Agency, 2010). Bu durum

Türkiye'de çok farklı değildir. Türkiye'de konut sektöründe kullanılan enerji tüketiminde % 26'ya karşılık gelmektedir (Yumurtacı & Donmez, 2013). Türkiye enerjide dışa bağımlı bir ülkedir. 2013 istatistiklerine göre, ithal enerji kaynakları yüzdesi% 75'dir. Bu bağımlılık, enerji talebindeki artışa bağlı olarak her geçen yıl artmaktadır (Türkyılmaz, 2015). Türkiye'de elektrik için üretilen enerji miktarı düşünüldüğünde, başlıca kaynak fosil yakıtlardır. İstatistikler,% 64'ünün fosil yakıtları kullanan termik santrallerden üretildiğini gösteriyor. Öte yandan,% 26'sı hidroelektrik santrallerinden,% 7'si ise diğer yenilenebilir enerji kaynaklarından üretilmektedir (TC Enerji ve Tabii Kaynaklar Bakanlığı, 2015). Bu istatistikler ve ısıtma için kullanılan enerji kaynakları düşünüldüğünde, Türkiye'de konut sektörünün önemli enerji kaynağı halen fosil yakıtlardır (Yumurtacı & Donmez, 2013).

Çalışmalar, yeryüzünün yüzey sıcaklığında sürekli artmanın birincil nedenin insan faaliyetleri olduğunu göstermiştir (Anderegg, Prall, Harold & Schneider, 2010; Doran & Zimmerman, 2009; Oreskes, 2004). Bu artışa yol açan başlıca faaliye, fosil yakıtların yakılmasıdır (IPCC, 2014). Fosil yakıtların yakılması sonucunda, sera gazı emisyonları atmosfere salınır ve küresel iklim değişikliğine neden olur (US Global Change Research Program, 2009). İklim değişikliği, uluslararası işbirliği gerektiren küresel bir sorundur (IPCC, 2014). Bu amaçla, çeşitli uluslararası anlaşmalar imazalanmıştır (örn., Kyoto protokolü, Paris iklim anlaşması). Tüm uluslararası anlaşmalarda vurgulanan, iklim değişikliğinin hafifletilmesi stratejilerinden biri olan sera gazı emisyonlarının azaltılmasıdır. Bu, (IPCC, 2014). Bu bağlamda, vatandaşların enerji tasarrufu davranışları (ETD), sera gazı emisyonlarını azaltmak için önemlidir ve iklim değişikliğinin azaltılmasına katkıda bulunur (Borgstede, Andersson & Johnsson, 2013; Macovei, 2015; Senbel, Ngo & Blair, 2014).

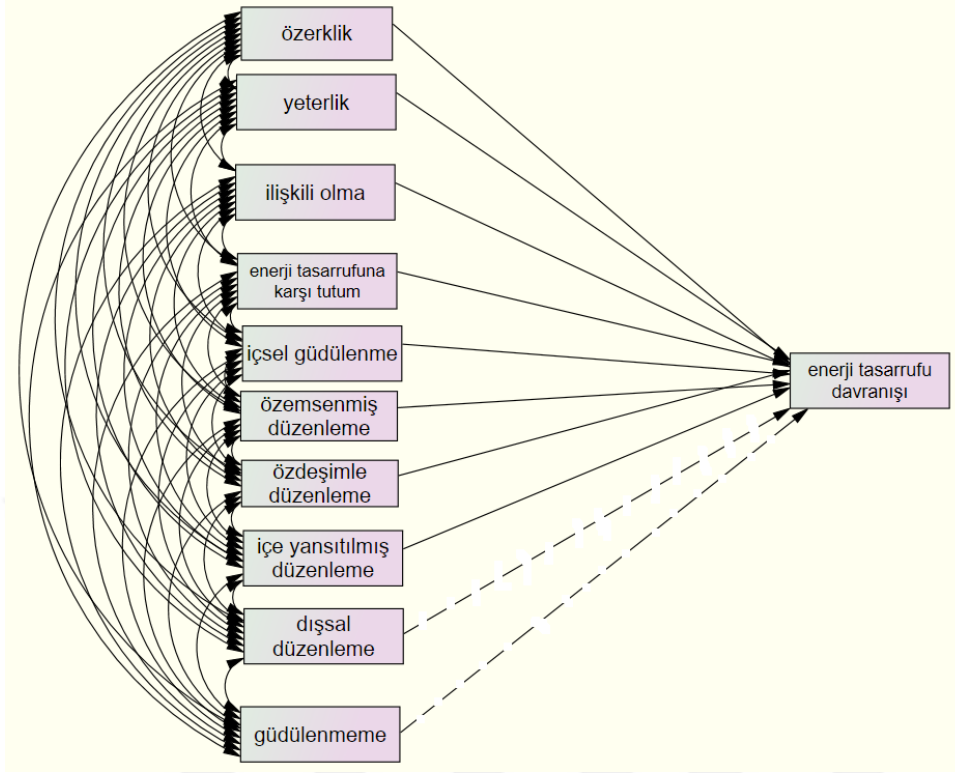
Okullar, enerji tasarrufu farkındalığını artırmak için önemli bir role sahiptir (Bodzin, Fu, Peffer & Kulo, 2013). Enerji kaynakları, enerji üretimi, enerji tüketimi ve enerji tasarrufu üzerine odaklanan fen eğitimi dersleri, öğrencileri enerji tasarrufu davranışları kazanmaları için destekleyebilir (Bodzin, 2012; Bodzin ve

diğerleri, 2013; DeWaters & Powers, 2011). Bilim öğretmenleri, gelecek nesilleri eğitmek ve tüm toplumu etkileyen önemli kararlar vermek için enerji tasarrufunun önemi konusunda bir bilince sahip olmalıdır (Koballa & Shrigley, 1983). Bu amaçla, koruyucu bilim öğretmenlerinin eğitim programları, gelecek nesilleri sürdürülebilir bir dünya için enerji tasarrufu sağlayan aktif sorumlu vatandaş olarak hazırlamak açısından da kritik öneme sahiptir (Mills & Tomas, 2009). Bu çalışmada, fen bilgisi öğretmen adaylarının enerji tasarrufu davranışları araştırılmıştır.

Enerji tasarrufu davranışının fen bilgisi eğitimi ve çevre eğitimi yoluyla desteklenebileceği bilinmektedir (DeWaters & Powers, 2011b). ABD’de (ör., DeWaters & Powers, 2011a; KEEP, 2003) ve Birleşik Krallık’ta (ör., Energy Matters projesi, Heijne, 2003) enerji tasarrufu davranışlarını desteklemek için çeşitli programlar geliktirildi. Eğitim programları yanında yaşadığımız çevrenin sürdürülebilirliğini desteklemek için insanların enerji tasarrufu konusunda olumlu tutumları ve motivasyonu olmalıdır (Abrahamse & Steg, 2009; Cheung, Chow, Fok, Yu ve Chou, 2016). Enerji tasarrufuna yönelik olumlu tutumları olan kişilerin enerji tasarrufu yapmaları daha olasıdır (Von Borgstede, Andersson & Johnsson, 2013; Martinsson, Lundqvist & Sundstrom, 2011). Motivasyon, enerji tasarrufu davranışlarında önemli bir role sahiptir. Motivasyon türüne göre davranış sıklığı değişir. İçsel olarak motive olan kişilerin, dışsal olarak motive olan insanlara kıyasla enerji tasarrufu yapma olasılığı daha yüksektir. Bir motivasyon teorisi olan öz belirleme kuramı, özerk benlik motivasyonu destekleyen psikolojik ihtiyaçları da göz önünde tutarak çeşitli motivasyon türleri tanımlamıştır (Ryan & Deci, 2000a). ÖBM teorisi ile yapılan araştırmalar, motivasyon türlerinin, enerji tasarrufu davranışları ile ilişkilerinin farklılık gösterdiğini ortaya koymuştur (ör., Sweeney, Webb, Mazzarol, Geoffrey & Soutar, 2014). Bu anlamda, bu çalışma, özellikle, fen öğretmen adaylarının enerji tasarrufu davranışları, özerk benlik motivasyonları, psikolojik temel ihtiyaçları ve enerji tasarrufuna karşı tutumları arasındaki ilişkilere odaklanmıştır. Bu amaçla, ilgili alan yazın ışığında bu değişkenler arasındaki ilişkiyi gösteren bir model önerilmiştir (Şekil G.1’e bakınız). Önerilen modelde

doğrudan ilişkiler incelenmiştir. Modelde gözlemlenen ilişkileri daha iyi anlamak için fen bilgisi öğretmen adayları ile mülakatlar yapılmıştır. Bu mülakatlarda enerji ile ilgili problemler hakkındaki farkındalıkları incelenmiştir. İnsanlar bir problemle ilgili farkındalık ve bilgiye sahip olduklarında, davranışları buna göre şekillenebilir (Delmas, Fischlein & Asensio, 2013). Bu farkındalığın ve bilginin, kişisel deneyimler ve üniversitede aldıkları dersler yoluyla elde edilebilebilir. Bu sebeple, bu çalışmada, yol modelinde önerilen ilişkilerin, enerji konusu ile ilgili farkındalıkları ile açıklanabileceği düşünülmektedir. Bu bağlamda, çalışmanın araştırma soruları aşağıda belirtilmiştir.

- Fen bilgisi öğretmen adaylarının enerji tasarrufuna yönelik tutumları, psikolojik temel ihtiyaçları, enerji tasarrufuna yönelik motivasyonları ve enerji tasarrufu davranışları nelerdir?
- Fen Bilgisi öğretmen adaylarının enerji tasarrufu davranışları ile enerji tasarrufuna yönelik tutumların, psikolojik temel ihtiyaçları ve enerji tasarrufuna yönelik motivasyonları arasındaki ilişkiler nelerdir?
- Fen bilgisi öğretmen adaylarının enerji ile ilgili problemler ve konular hakkındaki farkındalıkları, yol analizinde gözlemlenen ilişkileri nasıl açıklıyor?



Şekil 1 Önerilen yol analizi modeli

Modelde Yer alan İlişkiler

Tutum ve enerji tasarrufu davranışı arasındaki ilişkiyi araştıran çalışmalar bu iki değişkenin pozitif bir ilişkiye sahip olduğunu göstermektedir. Örneğin, Gadenne ve ark. (2011), tutumun enerji tasarrufu davranışı ile pozitif yönde ilişkili olduğunu göstermiştir. Bu ilişkiyi araştıran birçok çalışma, pozitif ve anlamlı korelasyonunu desteklemektedir (ör. Martinsson ve diğerleri, 2011; Von Borgstede ve ark., 2013). Tutumlara ek olarak, sosyoekonomik faktörler enerji tasarrufu davranışı için güçlü bir yordayıcı olarak ele alınmaktadır. Örneğin Martinsson ve ark. (2011), apartman bloklarında yaşayan sakinlerin enerji tasarrufuna karşı tutumlarının daha güçlü olduğu ve daha fazla enerji tasarrufu yaptıkları sonucuna varmıştır.

Motivasyon, bireylerin davranışlarını başlatmaya ve sürdürmesini sağlayan nedenlerden biridir (Darner, 2012; Pelletier ve diğerleri, 1998). Bu nedenle motivasyon hem çevre eğitimi hem de fen eğitimi konularında oldukça dikkat çekmektedir (Black & Deci, 2000; Pelletier ve diğerleri, 1998). Bu çalışma, fen

bilgisi öğretmen adaylarının enerji tasarrufu davranışlarının araştırılmasında öz belirleme kuramının rolüne dikkat çekmektedir. Öz belirleme kuramı çerçevesinde çevre dostu davranışları araştıran çalışmaların sayısı sınırlıdır (Darner, 2009, 2012). Bununla birlikte, bu kuramın çevre dostu davranışları açıklamada başarılı olduğunu gösteren sınırlı sayıda çalışma bulunmaktadır. Örneğin, Green-Demers ve ark. (1997), üniversite öğrencilerinin özerk benlik motivasyonu ve çevre dostu davranışları arasındaki ilişkiyi araştırmıştır. Çalışma, bu iki değişken arasında anlamlı ve pozitif bir ilişki olduğunu göstermiştir. Benzer bir çalışma De Groot ve Steg (2010) tarafından üniversite öğrencileriyle yapılmıştır. Bu çalışmada iki tür çevre dostu davranış çalışılmıştır. Bunlar; çevreci bir otomobil seçmek ve bir çevre organizasyonuna bağış yapmaktır. İçsel güdülenme, özemsenmiş düzenleme, özdeşimle düzenleme ve içe yansıtılmış düzenleme ile çevre dostu otomobil seçiminde anlamlı ve pozitif bir ilişki bulunmuştur. Bununla birlikte, dışsal düzenleme ile çevre dostu araç seçimi arasında anlamlı bir ilişki bulunmamıştır. Ayrıca güdülenmeme ile negatif bir ilişki bulunmuştur. Çevre örgütlerine bağış yapma sonuçları açısından, içsel güdülenme, özemsenmiş düzenleme, özdeşimle düzenleme ve içe yansıtılmış düzenleme anlamlı ve pozitif bir ilişki bulunmuştur. Öte yandan, bu davranışın dışsal düzenleme ile olan ilişkisi anlamsız bulunmuş olup güdülenmeme ile olan ilişkisi anlamlı ve negatif bulunmuştur.

Yöntem

Bu çalışmada yöntem olarak karma araştırma deseni kullanılmıştır. Bu yöntem çerçevesinde nicel ve nitel veriler toplanmıştır. Çalışmanın nicel kısmı Türkiye'de İç Anadolu Bölgesinde bulunan onbir üniversiteden toplanmıştır. Seçilen örnekleme uygun örnekleme yöntemi kullanılmış olup üçüncü ve dördüncü sınıf öğrencisi olan 1136 fen bilgisi öğretmen adayı çalışmaya katılmıştır. Çalışmanın nitel kısmı Ankarada bulunan üç üniversite ile yürütülmüştür. Çalışmanın bu kısmına 26 fen bilgisi öğretmen adayı katılmıştır. Bu katılımcıların 13'ü üçüncü sınıf, 13'ü dördüncü sınıf öğrencisidir. Nitel çalışmada yer alan katılımcılar ölçüt örnekleme yöntemi kullanılarak seçilmiştir. Bu bağlamda göz önünde bulundurulacak ölçütler: (1) Araştırmanın nicel fazında Ankara'daki katılımcı sayısı en yüksekti.

Bu nedenle katılımcılar Ankara'daki üç üniversiteden seçildi ve bu üniversiteler katılımcıların kişisel haklarını korumak için Üniversite A, Üniversite B ve Üniversite C olarak etiketlendi. (2) Çalışmanın nicel fazı, üçüncü ve dördüncü sınıf fen bilgisi öğretmen adayları ile gerçekleştirildi. Bu nedenle çalışmanın nitel kısmı da üçüncü ve dördüncü sınıf fen bilgisi öğretmen adayları ile gerçekleştirildi. (3) Gönüllüğü yüksek olan katılımcılar seçildi.

Veri Toplama Araçları

Nicel verilerin toplanması için beş ölçme aracı kullanılmıştır. Bu ölçme araçları: (1) Demografik bilgi anketi, (2) enerji tasarrufuna karşı tutum anketi, (3) Enerji tasarrufuna yönelik temel psikolojik ihtiyaçlar anketi, (4) Enerji tasarrufuna yönelik motivasyon anketi ve (5) Enerji tasarrufu davranışı anketi. Bu ölçekler hakkında daha detaylı bilgi aşağıda verilecektir. Bunların yanında, nitel verileri toplamak amacıyla Öğretmen Adayı Görüşme protokolü oluşturulmuştur.

Demografik Bilgiler Anketi:

Demografik bilgiler anketi araştırmacı tarafından geliştirilmiş olup, cinsiyet, sınıf düzeyi, öğrenim görülen üniversite, çocukluğun geçtiği bölge, çocukluğun geçtiği bölgede enerji santralinin olup olmadığı, anne eğitim düzeyi ve baba eğitimi düzeyi hakkında bilgi sunan bir ankettir.

Enerji Tasarrufuna Karşı Tutum Anketi

Abrahamse ve Steg (2009) tutumu "bir kişinin belirli bir davranış hakkında olumlu veya olumsuz değerlendirmesi" olarak tanımlamışlardır. Yazarlar, bu perspektiften yola çıkarak enerji tasarrufuna yönelik tutum ölçeğini geliştirmişlerdir. Bu araç, tek boyutlu faktör yapısında olup, dört maddeden oluşmaktadır. Ayrıca ölçek 5'li Likert tipindedir (1-kesinlikle katılmıyorum, 2-katılmıyorum, 3- kararsızım, 4- katılıyorum, 5- kesinlikle katılıyorum). Ölçeğin Cronbach alfa (α) değeri, Abrahamse ve Steg (2009) tarafından .74 olarak bulunmuştur. Ölçek Türkçeye araştırmacı tarafından çevrilmiş ve pilot çalışmada elde edilen veriler ölçeğin bir faktörlü olduğunu göstermiştir. Çalışmanın asıl verileri toplandıktan sonra, bir

faktörlü yapı doğrulayıcı faktör analizi ile test edilmiş ve bir faktörlü yapı desteklenmiştir ($\chi^2/df = 11.550$, CFI=.97, SRMR=.03, RMSEA=.09, 90% CI for RMSEA= .06-.13). Asıl veri analizine göre ölçeğin Cronbach alfa (α) değeri .70 olarak bulunmuştur.

Enerji Tasarrufuna Yönelik Temel Psikolojik İhtiyaçlar Anketi

Temel psikolojik ihtiyaçlar üç faktör yapısındadır: (1) özerklik, (2) yeterlik ve (3) ilişkili olma (Deci & Ryan, 1985). Sweeney ve ark. (2014), Deci & Ryan'ın (1985) çalışmasına dayanarak, enerji tasarrufuna yönelik temel psikolojik ihtiyaçlar anketini geliştirdi. Bu araç, 7'li Likert ölçeğidir (1-kesinlikle katılmıyorum, 7-kesinlikle katılıyorum) ve 9 madde içermektedir. Sweeney ve ark. (2014), ölçeğin iki faktör yapısında olduğunu bulmuştur: (1) özerklik / yeterlilik ve (2) ilişkili olma. Ölçeğin Cronbach alfa (α) değeri sırasıyla .88 ve .94'tür. Bu ölçek Türkçeye araştırmacı tarafından adapte edilmiş ve ölçeği Türk kültürüne uygun hale getirmek ve ölçeğin güvenirlik değerini yükseltmek için 4 madde daha eklenmiştir. Pilot çalışmadan önce ölçek ile ilgili uzman görüşü alınmış ve gerekli düzeltmeler yapılmıştır. Pilot çalışmadan toplanan veri ile açımlayıcı faktör analizi yapılmış ve iki faktör ortaya çıkmış ve bir maddenin çalışmadığı görülmüştür. Bu madde ölçekten çıkarılmıştır. Çalışmanın asıl verileri toplandıktan sonra iki faktörlü yapı doğrulayıcı faktör analizi ile test edilmiş ve verilerin iyi bir model uyumu gösterdiği bulunmuştur ($\chi^2/df = 6.882$, CFI=.94, SRMR=.04, RMSEA=.07, 90% CI for RMSEA= .06 - .08). Sonrasında, faktörlerin Cronbach alpha value (α) değerleri hesaplanmış ve özerklik/yeterlik için .86, ilişkili olma için .82 bulunmuştur.

Enerji Tasarrufuna Yönelik Motivasyon Anketi

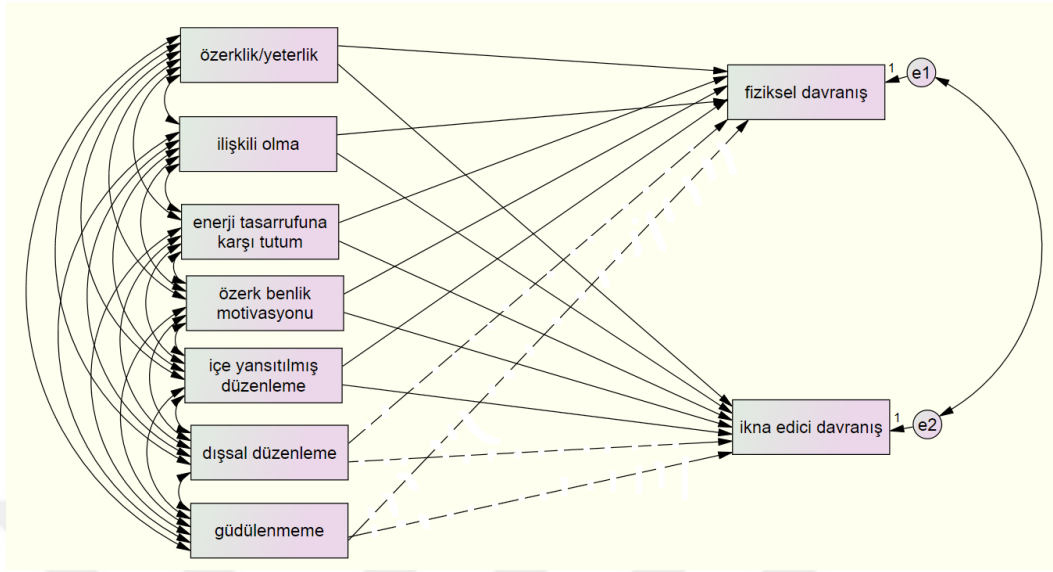
Çevreye Yönelik Motivasyon Ölçeği Pelletier ve ark (1998) tarafından geliştirilmiş ve Karaarslan (2011) tarafından Türkçe'ye uyarlanmıştır. Bu ölçek, 7 maddelik bir Likert ölçeğidir (1-kesinlikle katılmıyorum, 7- kesinlikle katılıyorum) ve 21 madde içermektedir. Ölçek altı faktör yapısındadır: (1) içsel güdülenme, (2) özemsenmiş düzenleme, (3) özdeşimle düzenleme, (4) içe yansıtılmış düzenleme, (5) dışsal düzenleme ve (6) güdülenmeme. MTES'in Türkçe versiyonunun alt boyutlarının

Cronbach alfa (α) değeri .70 ile .90 arasında değişmektedir. Bu ölçme aracı, araştırmacı tarafından enerji tasarrufuna uyarlanıştır ve enerji tasarrufuna yönelik motivasyon olarak adlandırılmıştır. Bu ölçek başlangıçta 32 maddeyle oluşturulmuştur. Uzman görüşleri alındıktan sonra pilot çalışma uygulanmıştır. Pilot çalışma sonucunda madde sayısı 27'ye düşürülmüştür. Çalışmanın asıl verileri ile açımlayıcı faktör analizi uygulanmış ve Kaiser kriterine göre ölçeğin faktör sayısının dört olduğu sonucuna varılmıştır. Bu faktörler: özerk benlik motivasyonu, içe yansıtılmış düzenleme, dışsal düzenleme ve güdülenmemedir. Doğrulamalı faktör analizi dört faktörlü yapıyı desteklemiştir ($\chi^2/df = 4.153$, CFI=.93, SRMR=.05, RMSEA=.05, 90% CI for RMSEA= .05-.06). Cronbach alfa (α) değeri özerk benlik motivasyonu, içe yansıtılmış düzenleme, dışsal düzenleme ve güdülenmeme faktörleri için hesaplanmış ve sırasıyla .92, .82, .79 and .74 olarak bulunmuştur.

Enerji Tasarrufu Davranışı Anketi

Enerji tasarrufu davranışı anketi 5'li likert yapısındadır (1-hiçbir zaman, 2-nadiren, 3-bazen, 4-sıklıkla, 5-her zaman). Ölçekte yer alan maddeler DeWaters (2011) ve Sahin (2013)'den alınmıştır. İki pilot çalışma sonucunda ölçekteki madde sayısı 13 olarak belirlenmiş ve ölçek son halini almıştır. Ölçek enerji tasarrufu ile ilgili iki faktörden oluşmaktadır: Fiziksel davranış ve ikna davranışı. Bu yapı ikinci pilot çalışmada açımlayıcı faktör analizinde ortaya çıkmış ve çalışmanın asıl verileri kullanılarak doğrulamalı faktör analizi ile de desteklenmiştir ($\chi^2/df = 7.736$, CFI=.89, SRMR=.05, RMSEA=.08, 90% CI for RMSEA= .08-.09). Cronbach alfa (α) değeri fiziksel davranış için .80, ikna davranışı için .73 bulunmuştur.

Ölçeklerin faktör yapısına göre, önerilen yol analizi geliştirilmiştir. Bu model Şekil 2 de gösterilmektedir.



Şekil 2 Geliştirilmiş yol analizi modeli

Öğretmen Adayı Görüşme Protokolü

Bu protokolda yer alan soruların bir kısmı Gwekwerere (2015)'in çalışmasından uyarlanmıştır. Gwekwerere (2015) çalışması için çevre ile ilgili problemler ve konular ile ilgili bir protokol geliştirmiş, bu protokolda yer alan sorular enerji ile ilgili problemlere ve konulara araştırmacı tarafından uyarlanmıştır. Bu protokol, öğretmen adaylarının enerji problemleri ve konuları ile ilgili farkındalıklarını araştırmak için oluşturulmuştur. Bu farkındalığın, modelde yer alan ilişkileri açıklayabileceği düşünüldüğü için, çalışmaya dahil edilmiştir.

Verilerin Analizi

Nicel verilerin analizinde ön analizler, betimsel ve çıkarımsal analizler kullanılmıştır. Bu amaçla IBM SPSS Statistics 23 ve AMOS 18 software programları kullanılmıştır. Doğrulayıcı faktör analizi ve yol analizi için referans alınan uyum indeksleri Tablo 2'de gösterilmiştir. Nitel verilerin analizinde Maxqda 12 kullanılmıştır. Nitel veriler analiz edilmeden önce tüm ses kayıtları birebir deşifre edilmiştir.

Tablo 1

Çalışmada referans alınan model uyum indeksleri

Model Fit Index	Values for Good Fit
Chi-square (χ^2)	küçük
χ^2/df	< 5
CFI	$\geq .90$
SRMR	< .10
RMSEA	< .10
90% CI for RMSEA	Dar aralık

Bulgular

Çalışmada kullanılan değişkenlerin betimsel sonuçları Tablo 2’de sunulmuştur. Bu sonuçlara göre, fen bilgisi öğretmen adaylarının enerji tasarrufuna karşı tutumları oldukça yüksek bulunmuştur. Bu da demek oluyorki, Fen Bilgisi öğretmen adayları, enerji tasarrufu davranışları hakkında pozitif bir algıya sahipler.

Enerji tasarrufuna yönelik temel psikolojik ihtiyaçlar incelendiğinde, özerklik/yeterlik ihtiyaçları bakımından fen bilgisi öğretmen adayları kendilerini yeterli görmekte ve bu davranışla ilgili gönüllü oldukları görülmektedir. İlgili olma ile ilgili skorları da oldukça yüksek bulunmuştur. Bu da gösteriyor ki, fen bilgisi öğretmen adaylarının bulundukları sosyal çevrenin bu davranışa önem verdikleri hakkında bir algılarının olduğunu ve bu yönüyle bulundukları sosyal çevreyle ilişkili olduklarını hissettiklerini göstermektedir. Enerji tasarrufuna yönelik motivasyonları ile ilgili skorlar incelendiğinde, en yüksek ortalamanın özerk benlik motivasyonuna ait olduğu görülmektedir. İçer yansıtılmış düzenleme ile ilgili puan da oldukça yüksektir. Dışsal düzenleme ile güdülenmemeye ait puanlar ise oldukça düşüktür. Bu sonuçlar gösteriyor ki, pek çok öğretmen adayının mtivasyon türü özerk benlik motivasyonu ya da içer yansıtılmış düzenleme olup, bu da davranışın pek çok öğretmen adayı tarafından oldukça içselleştirildiğini göstermektedir.

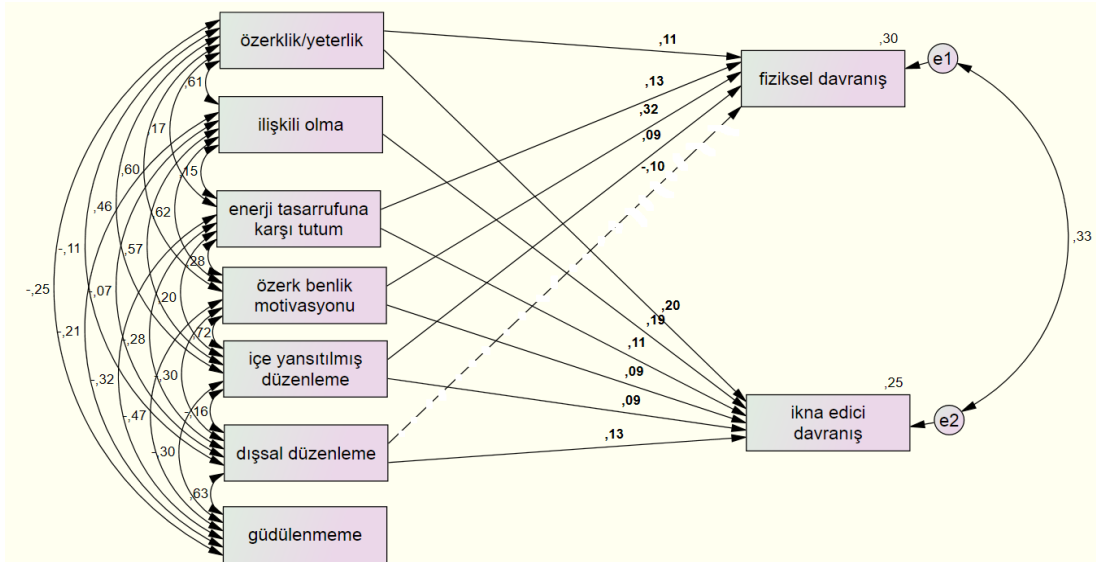
Tablo 2
Değişkenlerin betimsel analiz sonuçları

	<i>M</i>	<i>SD</i>	<i>Min</i>	<i>Max</i>
<i>Enerji tasarrufuna karşı tutum</i>	3.83	.71	1	5
<i>Enerji tasarrufuna yönelik temel psikolojik ihtiyaçlar</i>				
Özerklik/yeterlik	5.21	0.94	2.25	7
İlişkili olma	5.00	1.18	1.00	7
<i>Enerji tasarrufuna yönelik motivasyon</i>				
Özerk benlik motivasyonu	5.78	.87	2.14	7
İçe yansıtılmış düzenleme	5.46	1.26	1	7
Dışsal düzenleme	2.56	1.44	1	7
Güdülenmeme	2.31	1.22	1	7
<i>Enerji tasarrufu davranışları</i>				
Fiziksel davranış	4.26	.57	1	5
İkna edici davranış	3.45	.77	1	5

Yol Analizinin Sonuçları

Yol analizi bir yapısal eşitleme modeli türü olup, bu çalışmada çıkarımsal analiz olarak kullanılmıştır. Şekil 2’de gösterilen model yol analiziyle test edilmiştir. Bu amaçla AMOS 18 software programı kullanılmıştır. Model parametrelerinin hesaplanmasında maximum benzerlik metodu kullanılmıştır. Analiz yapılmadan önce, verilerin analize uygunluğu test edilmiştir. Sonuçlar göstermiştir ki, veriler yol analize uygun olup, elde edilecek sonuçların güvenilir şekilde yorumlanabilecektir. Verilerin analize uygunluğu test edildekten sonra, model belirlenmiştir (Şekil 2’ye bakınız). Bu yol analizinde sadece doğrusal ilişkilerin incelenmesi amaçlanmıştır. Bağımlı değişen olan enerji tasarrufu davranışının iki faktörlü yapıda olup, bu faktörler ilişkilidir. Kline (2011) bu değişkenlerin hata varyanslarına kovaryasyon eklenmesini önerir. Bu sebeple, bu iki değişken arasına kovaryasyon eklenmiştir.

Model analiz edildiğinde, üç yolun istatistiksel olarak anlamlı olmadığı bulunmuştur. Bu yollar, güdülenmemeden fiziksel davranışa giden yol ($\beta = .02$, $p < .05$), güdülenmemeden ikna davranışına giden yol ($\beta = .05$, $p < .05$) ve ilişkili olmadan fiziksel davranışa giden yoldur ($\beta = .05$, $p < .05$). Bu yollar modelden silindi ve model yeniden çalıştırıldı. Bunlar dışında modelde yer alan tüm yollar istatistiksel olarak anlamlıydı. Bunu takiben, modelin fit indisleri incelendi. Fit indisleri arasında Kline (2011)'in önerdiği gibi ki- kare, ki-kare uyum testi (χ^2/df), CFI, RMSEA and SRMR değerleri göz önüne alındı. Ki-kare değeri örneklem sayısından etkilendiğinden ki-kare uyum testi değeri değerlendirmeye alındı (Kline, 2011). Yapılan analizde ki-kare uyum testi değeri 1.502 olarak bulundu. Bu değer Sumer (2000)'e göre referans aralığında olup, iyi uyum indeksine işaret eder. CFI değeri de .99 bulunmuştur, ki bu da iyi bir fit indis değeridir. Aynı şekilde RMSEA ve SRMR değerleri de iyi fit indislerine işaret etmiştir (RMSEA= .021; SRMR: .006; 90% CI for RMSEA: .00, .058). Sonuç olarak, yol analizinden elde edilen uyum indeksleri göstermiştir ki, önerilen model veri ile iyi bir uyuma sahiptir.



Şekil 3 AMOS çıktısında yer alan istatistiksel olarak anlamlı olan standarize edilmiş parametre değerleri

Modelde bağımlı ve bağımsız değişkenler arasındaki ilişkiler standardize edilmiş Beta (β) katsayıları üzerinden değerlendirilmiştir. Şekil 3’de bu değerler görülmektedir. Bu bağlamda en yüksek ilişki, özerk benlik motivasyonu ile fiziksel davranış arasındaki pozitif ilişkide bulunmuştur. Bu ilişkinin etki değeri orta düzeydedir. Diğer taraftan içe yansıtılmış düzenleme ile fiziksel davranış arasındaki ilişkinin etki değeri küçük bulunmuştur. Bu analiz gösteriyor ki, fen bilgisi öğretmen adaylarının özerk benlik motivasyonları arttıkça, fiziksel davranış türündeki enerji tasarrufu davranışları artacaktır. Modelde İkna edici davranışla en yüksek ilişki psikolojik ihtiyaçların alt boyutları arasında çıkmıştır. Bu ilişkilerin etki değeri küçüktür. Yani, fen bilgisi öğretmen adaylarının özerklik/yeterlik ve ilişkili olma ihtiyaçları ne kadar çok karşılanırsa, ikna edici davranışları da o kadar çok artacaktır. Modelde hipotez edilen yollar düşünüldüğünde, dışsal motivasyon ile ikna edici davranış arasındaki ilişki farklı bulunmuştur. Şöyle ki, bu iki değişken arasında negatif bir ilişki önerilmişken, analizler pozitif ve düşük etkiye sahip bir ilişki olduğunu ortaya çıkarmıştır.

Nitel Verilerin Sonuçları

Çalışmanın bu kısmı fen bilgisi öğretmen adaylarının enerji ile ilgili problemler ve konulardaki farkındalıkları üzerine olmuştur. Bu bağlamda, analiz sonucunda Tablo 3de belirtilen kategoriler ortaya çıkmıştır.

Tablo 3

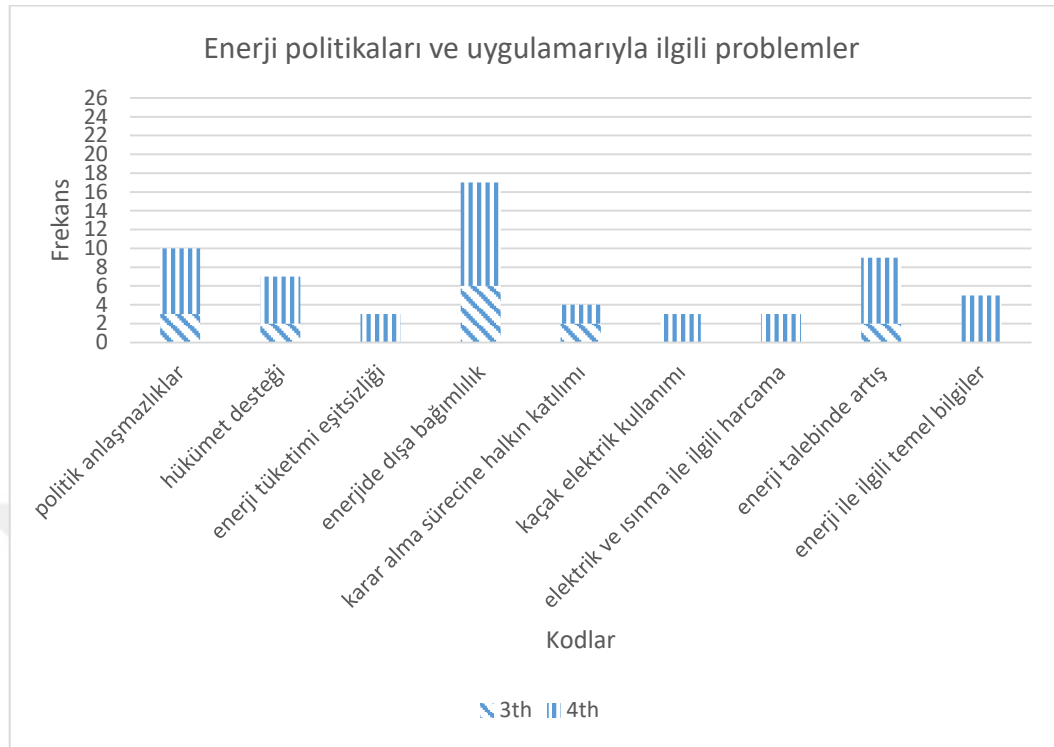
Enerji ile ilgili sorunlar ve konularla ilgili farkındalık temaları ve kategorileri ve çözümleriyle ilgili algıları

Tema	Kategoriler/alt kategoriler
Enerji ile ilgili problem ve konular hakkındaki farkındalıkları	• Enerji politikaları ve uygulamalarıyla ilgili problemler • Enerji kaynaklarının etkileri ile ilgili problemler • Enerji tasarrufuyla ilgili problemler
Enerji ile ilgili problem ve konuların çözümü ile ilgili farkındalıkları	• Enerji politikaları ve uygulamalarıyla ilgili çözümler • Teknolojiyi içeren çözümler • Enerji kaynaklarıyla ilgili çözümler • Enerji tasarrufuyla ilgili çözümler • Çevreci bakış açısı

Bu kategoriler altında ortaya çıkmış kodlar ışığında fen bilgisi öğretmen adaylarının bu problemler ve konularla ilgili farkındalıkları incelenecektir. Ayrıca, fen bilgisi öğretmen adaylarının üniversitede aldıkları dersler bu farkındalıklarının oluşmasında rol oynamış olabileceğinden, derslerinde bu konuların nasıl ele alındığı da sorulmuştur. Bu sebeple, bu bölümün son kısmında, fen bilgisi öğretmen adaylarının verdiği bilgiler ve derslerin izlenceleri ışığında derslerin içeriklerinden bahsedilmiştir. Bu çalışma deneysel bir çalışma olmadığından neden-sonuç ilişkisi kurulmadığı hatırlatılmalıdır. Fen bilgisi öğretmen adaylarının farkındalıklarının kaynağı dersler dışında sosyoekonomik statüleri ve bu konuya ilgileri gibi faktörler de etkili olabilir.

Enerji politikaları ve uygulamalarıyla ilgili problemler

Analizlerde bu problemle ilgili çıkan kodlar: (a) politik anlaşmazlıklar, (b) hükümet desteği, (c) enerji tüketimi eşitsizliği, (d) enerjide dışa bağımlılık, (e) karar alma sürecine halkın katılımı, (f) kaçak elektrik kullanımı, (g) elektrik ve ısınma ile ilgili harcama, (h) enerji talebinde artış ve (i) enerji ile ilgili temel bilgiler. Şekil 4'te bu kodlara ait frekanslar görülmektedir. Bu frekanslar, bu kodlardan bahseden fen bilgisi öğretmen adaylarının sayısını temsil etmektedir.



Şekil 4 Sınıf düzeyinde enerji politikaları ve uygulamalarına ilişkin problemlerin frekansları

Şekil 4’te de görüldüğü gibi, enerji politikaları ve uygulamaları ile ilgili fen bilgisi öğretmen adaylarının farkındalıklarının en yüksek olduğu problemler enerjide dışa bağımlılık, enerji talebindeki artış ve politik anlaşmazlıklardır. Bu farkındalıkları özerk benlik motivasyonu ile fiziksel davranış türündeki enerji tasarrufu davranışı arasındaki ilişkinin yüksek çıkmasına katkı sağlamış olabilir. Fen bilgisi öğretmen adaylarının geri kalan problemlerle ilgili farkındalıkları oldukça düşüktür. Bu problemlerle ilgili farkındalıklarının düşük olması, özerk benlik motivasyonu ile ikna edici davranışlar arasındaki ilişkinin düşük olmasına sebep olmuş olabilir.

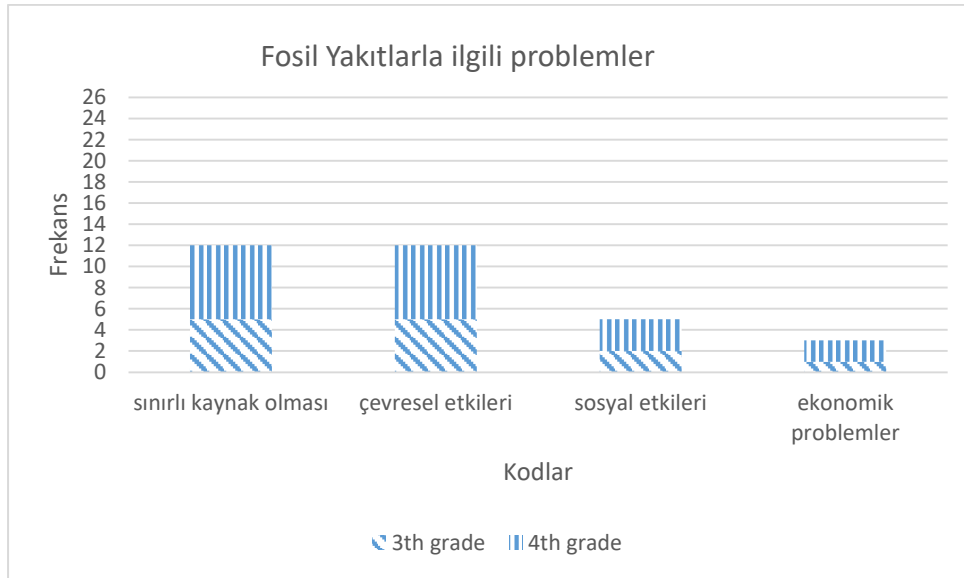
Enerji Kaynaklarının Etkileri ile ilgili Problemler

Enerji kaynaklarının etkileri ile ilgili sorunlar, enerji kaynakları türlerine göre kategorize edilmiştir. Bu nedenle, analizde alt kategoriler ortaya çıkmıştır. Bu alt kategoriler: (a) fosil yakıtlar, (b) yenilenebilir enerji, (c) hidroelektrik santralleri, (d) rüzgar santralleri, (e) dalga gücü ve (f) nükleer enerji ile ilgili sorunlar. Hidroelektrik, dalga ve rüzgar enerjisi santralleri yenilenebilir enerji kaynakları

olmakla birlikte, görüşmelerde bu yenilenebilir türler ile ilgili özel sorunlar ortaya çıkmıştır. Bu nedenle, bu yenilenebilir enerji kaynaklarına özgü alt kategoriler oluşturuldu. Yenilenebilir enerji ile ilgili sorunlar kategorisinde katılımcılar yenilenebilir enerji türleri arasında bir ayrım yapmadan genel farkındalıklarından bahsettiler.

Fosil Yakıtlarla ilgili Problemler

Şekil 5'te görüldüğü gibi, fosil yakıtlarla ilgili fen bilgisi öğretmen adaylarının farkındalıklarını oluşturan kodlar sınırlı kaynak olmaları, çevresel etkileri, sosyal etkileri ve ekonomik problemlerdir. Bu problemlerden, katılımcıların en çok farkında oldukları problemler fosil yakıtların sınırlı kaynak olmaları ve çevresel etkileri. Bu problemler hakkında farkındalıkları özerk benlik motivasyonu ile fiziksel davranış arasındaki ilişkiyi yükseltmiş olabilir. Şöyleki, bu problemler hakkındaki farkındalık, katılımcıların enerji tasarrufu davranışını içselleştirmelerine yardımcı olmuş olabilir ve bu da, fiziksel davranışlarını arttırmış olabilir. Dolayısıyla, özerk benlik motivasyonu ile fiziksel davranış arasındaki ilişki güçlenmiş olabilir.

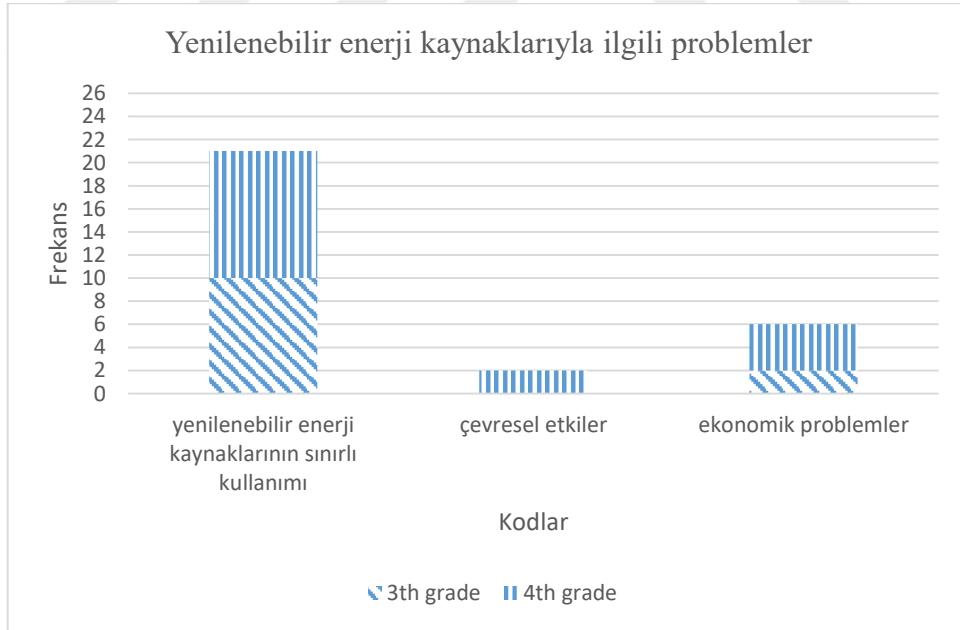


Şekil 5 Sınıf düzeyinde fosil yakıtlarla ilgili problemlerin frekansları

Oysaki fosil yakıtların sosyal etkilerinden ve ekonomik problemlerden bahseden fen bilgisi öğretmen sayısı oldukça düşüktür. Bu da, bu problemlerle ilgili farkındalıklarının daha düşük olduğunu göstermektedir. Bu sonuç gösteriyorki, pek çok öğretmen adayının fosil yakıtların çevresel ve beşeri etkileri ile ilgili çoklu bakış açısına sahip değiller. Yani, bu problemlerle ilgili bütüncül bir bakış açısına sahip değiller. Bu sebeple, özerk benlik motivasyonuna sahip olsalar bile, bu problemleri sosyal çevreleriyle paylaşmaktan çekiniyor olabilirler. Bu durumda, özerk benlik motivasyonu ile ikna edici türdeki enerji tasarrufu davranışı arasındaki düşük ilişkiyi açıklıyor olabilir.

Yenilenebilir Enerji Kaynaklarıyla ilgili Problemler

Bu kategoriye ilişkin analizlerden üç temel kod ortaya çıkmıştır: Yenilenebilir enerji kaynaklarının sınırlı kullanımı, çevresel etkileri ve ekonomik problemler. Şekil 6, bu kodlara dair bulunan frekans değerlerini göstermektedir.



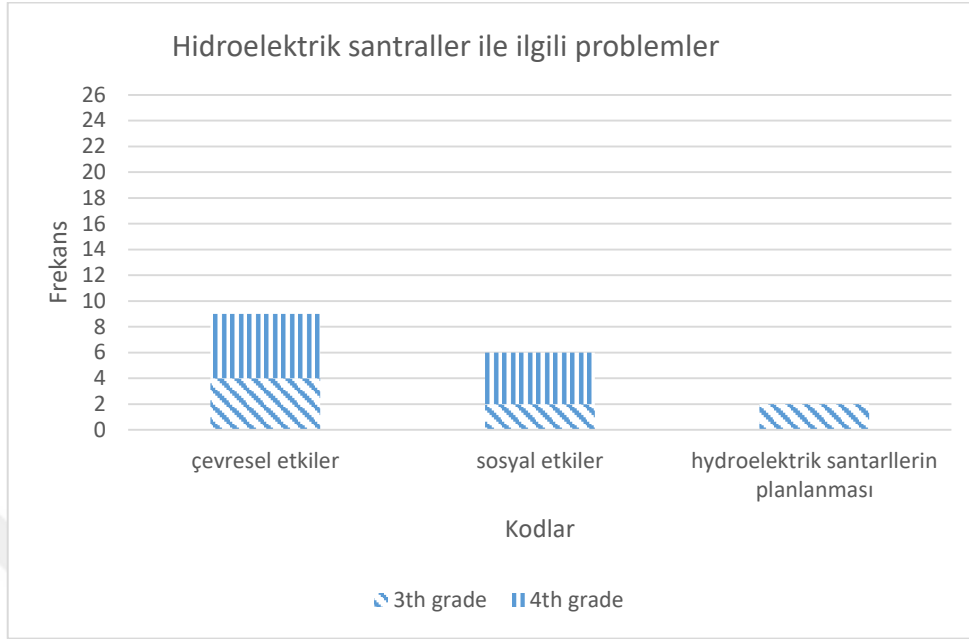
Şekil 6 Sınıf düzeyinde yenilenebilir enerji kaynaklarıyla ilgili problemlerin frekansları

Şekil 6'ya göre, çok sayıda katılımcı yenilenebilir enerjinin sınırlı kullanımına değinmiştir. Bu katılımcıların çoğunluğu temel olarak güneş ve rüzgar enerjisinin sınırlı kullanımından bahsetmiştir. Yenilenebilir enerjinin sınırlı kullanımı fosil yakıtların kullanımına neden olduğundan, bu bilinçle fen bilgisi öğretmen adayları daha fazla fiziksel davranış türündeki enerji tasarrufu davranış sergilemiş olabilirler. Benzer bir şekilde, birçok fen bilgisi öğretmen adayı yukarıda belirtildiği gibi, fosil yakıtların çevresel etkilerinin farkındaydı. Dolayısıyla, bu farkındalık, özerk benlik motivasyonu ve fiziksel davranış arasındaki ilişkide rol oynamış olabilir.

Yenilenebilir enerji kaynaklarının çevresel etkilerinden bahseden katılımcı sayısının ise çok az sayıda olduğu bulunmuştur. Bu sebeple, bu farkındalık modelde gözlemlenen ilişkiler üzerinde bir etkiye sahip olmamış olabilir. Ekonomik problemlerden ise bazı katılımcılar bahsetmiştir. Bu katılımcılar yenilenebilir enerji kaynaklarının enerji üretmek için pahalı olabileceğini düşünüyorlardı. Bu farkındalık, öğretmen adaylarının fiziksel davranışlarını rasyonelleştirmelerine yardımcı olmuş olabilir.

Hidroelektrik santraller ile ilgili problemler

Hidroelektrik santrallerle ilgili problemler kapsamında, fen bilgisi öğretmen adayları hidroelektrik santrallerin çevresel etkilerine, sosyal etkilerine ve hidroelektrik santrallerin planlanmasına değinmişlerdir. Bu problemlere ait frekans değerleri Şekil 7'de verilmiştir.



Şekil 7 Sınıf düzeyinde hidroelektrik santralleriyle ilgili problemlerin frekansları

Hidroelektrik santrallerin etkileri arasında en çok belirtilen sorun çevre üzerindeki etkilerdir. Katılımcıların yarısından azı bu sorundan bahsetti. Katılımcıların çoğunluğu bu sorunun farkında olmadığı sonucuna ulaşılabilir. Bu problemten bahseden katılımcıların bir kısmı derslerinde geçen belgesellere referans verirken, bir kısmı da internette ve TV’de rastladıkları haberlere referans verdiler. Bir kısmı da memleketlerinde bu etkileri yaşadıklarını dile getirdi. Yani, üniversitede yer alan dersler, medya ve yaşam deneyimi bu farkındalığın oluşmasında etken olabiliyor. Bu farkındalık fiziksel davranışın içselleştirilmesinde rol oynayabilir ve özerk benlik motivasyonu ve fiziksel davranış arasındaki ilişkide rolü olabilir.

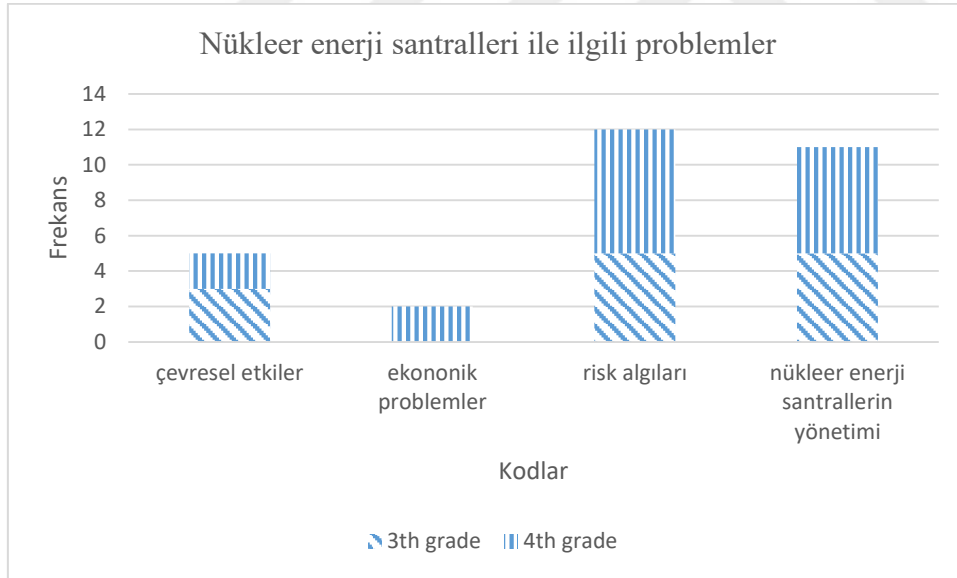
Hidroelektrik santrallerin sosyal etkilerinden bahseden fen bilgisi öğretmen adayı çevresel etki ile karşılaştırıldığında oldukça düşüktür. Bu farkındalık öğretmen adaylarının enerji tasarrufu davranışlarını anlamlandırmalarına ve bu davranışları içselleştirmelerine yardımcı olmuş olabilir. Böylelikle özerk benlik motivasyonu ve fiziksel davranış arasındaki ilişkiyi güçlendirmiş olabilir. Diğer taraftan, hidroelektrik santrallerin planlanması ile ilgili problemleri belirten katılımcı sayısı çok azdır. Bu sebeple bu farkındalığın modelde gözlemlenen ilişkilerde etkisi olmamış olabilir.

Rüzgar ve dalga enerji santralleri ile ilgili problemler

Fen bilgisi öğretmen adaylarının rüzgar ve dalga enerji santralleri ile ilgili problemler hakkındaki farkındalıkları oldukça düşük bulunmuştur. Bu santrallerin çevresel ve sosyal etkilerinden bahseden katılımcı sayısı çok düşük olduğundan, bu konu hakkındaki farkındalık modelde yer alan ilişkileri etkilememiş olabilir.

Nükleer enerji santralleri ile ilgili problemler

Nükleer enerji santralleri ile ilgili problemler kapsamında fen bilgisi öğretmen adayları dört problemten bahsetmişlerdir: Çevresel etkiler, ekonomi problemler, risk algıları, nükleer enerji santrallerin yönetimi. Bu problemlerin frekanslarına ait bulgular Şekil 8’de gösterilmiştir.



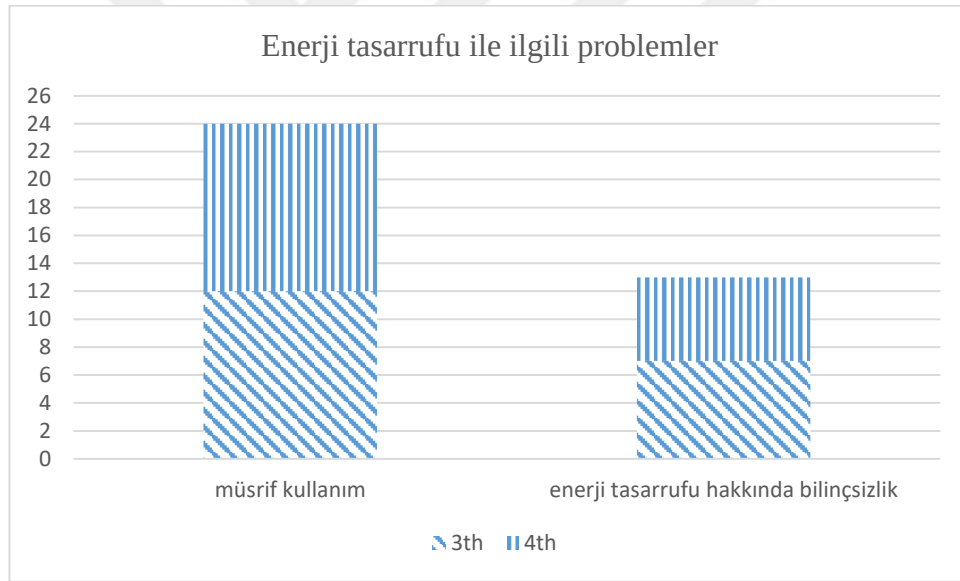
Şekil 8 Sınıf düzeyinde nükleer enerji santralleriyle ilgili problemlerin frekansları

Nükleer enerji santrallerinin çevresel etkileri ve ekonomik problemlerinden bahseden fen bilgisi öğretmen adayı sayısı azdır. Bu sebeple, bu problemlerle ilgili farkındalığın yol analizi modelinde yer alan ilişkiler üzerinde etkisi olmamış olabilir. Oysaki, risk algıları ve nükleer enerji santrallerinin yönetimi ile ilgili

problemlerden pek çok öğretmen adayı bahsetmiştir. Medyada son dönemlerde bu konu riskler üzerinden yer bulduğundan, fen bilgisi öğretmen adaylarının bu konuyla ilgili farkındalıklarının oluşmasının bir sebebi olabilir. Risk algıları ve nükleer enerji santrallerinin yönetimi ile ilgili problemler özerk benlik motivasyonu ve fiziksel davranış türündeki enerji tasarrufu davranışı arasındaki ilişkiyi güçlendirmiş olabilir.

Enerji Tasarrufu ile ilgili Problemler

Enerji tasarrufu ile ilgili problemler kapsamında fen bilgisi öğretmen adayları iki problemten bahsetmişlerdir: müsrif kullanım ve enerji tasarrufu hakkında bilinçsizlik. Bu problemlerin frekanslarına ait bulgular Şekil 9’da gösterilmiştir.



Şekil 9 Sınıf düzeyinde enerji tasarrufu ile ilgili problemlerin frekansları

Enerji ile ilgili problemlere ait kategoriler düşünüldüğünde fen bilgisi öğretmen adaylarının farkındalıklarının en yüksek olduğu problem enerji tasarrufu ile ilgili problemler olmuştur. Bu problemlerle ilgili farkındalıkları özerk benlik motivasyonlarını geliştirmelerine ve fiziksel davranışlarını arttırmalarına yardımcı olmuş olabilir. Böylelikle, bu iki değişken arasındaki ilişkiyi güçlendirmiş

olabilir. Ancak, fen bilgisi öğretmenlerinin büyük bir çoğunluğu enerji problemleriyle ilgili pek çok problemin farkında olmadığı için, bu problemlerle ilgili çoklu bir perspektife (muldimensional perspective) sahip olmadıkları için enerji tasarrufu hakkında özerk benlik motivasyonuna sahip olsalar da, bulundukları çevredeki insanları bu davranışa ikna etmede sıkıntı yaşıyor olabilirler.

Enerjinin kullanımı/üretimi/tasarrufu ve küresel ısınma arasındaki ilişki hakkındaki farkındalıkları

Pek çok fen bilgisi öğretmen adaylarının enerjinin kullanımı/üretimi/tasarrufu ve küresel ısınma arasındaki ilişki hakkındaki farkındalıklarının düşük olduğu ve bu ilişki ile ilgili kavram yanılgıları olduğu ortaya çıkmıştır. Kavram yanılgıları arasında küresel ısınmayı hava kirliliği ve ozon tabakasının incilmesi ile ilişkilendirmeleri gösterilebilir. 26 fen bilgisi öğretmen adayının arasından sadece 8'i bu ilişkinin farkında olup, kavram yanılgıları yoktur. Bu konu ile ilgili farkındalık özerk benlik motivasyonu ile fiziksel davranış arasındaki ilişkiyi güçlendirmede rol oynamış olabilir.

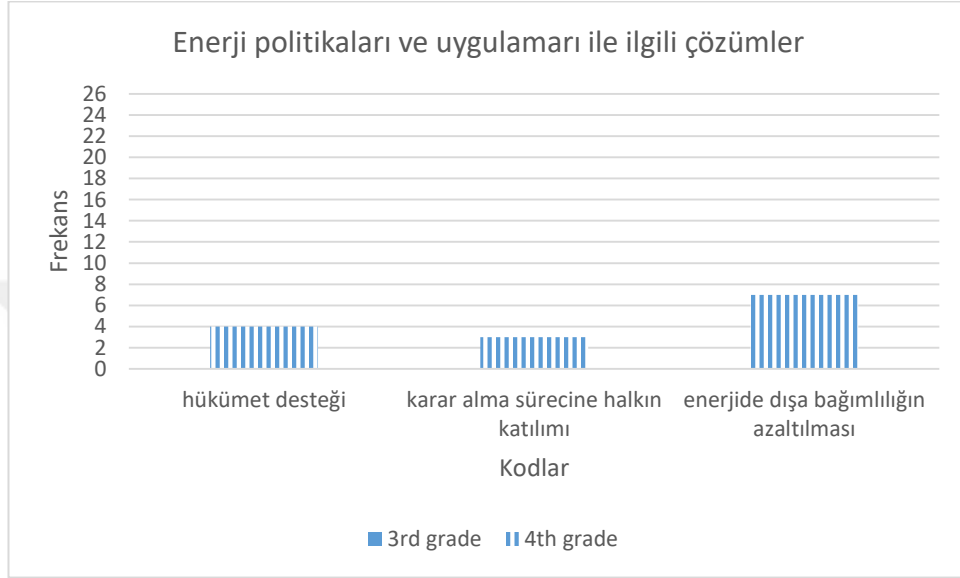
Enerji ile ilgili problemlerin çözümüne dair farkındalık

Enerji ile ilgili sorunlar ve konular çok boyutludur. Çözümleri de bu özelliği yansıtacak şekilde ekonomi, politika, toplum ve çevre ile de ilgilidir. Buna paralel olarak analizlerde çözümleri yansıtan beş kategori çıkmıştır: (a) enerji politikaları ve uygulamalarıyla ilgili çözümler, (b) teknolojiyi içeren çözümler, (c) enerji kaynaklarıyla ilgili çözümler, (d) enerji tasarrufuyla ilgili çözümler, (e) çevreci bakış açısı.

Enerji Politikaları ve Uygulamaları ile İlgili Çözümler

Enerji politikaları uygulamaları ile ilgili çözümlerde üç kod ortaya çıkmıştır: (a) hükümet desteği, karar alma sürecine halkın katılımı ve enerjide dışa bağımlılığın azaltılması. Şekil 10, bu çözüm ile ilgili frekans değerlerini göstermektedir. Bu

çözümleri öneren katılımcı sayısı çok az olduğundan, bu farkındalık modelde yer alan ilişkileri etkilememiş olabilir.



Şekil 10 Sınıf düzeyinde enerji politikaları ve uygulamaları ile ilgili çözümlerin frekansları

Teknolojiyi İçeren Çözümler

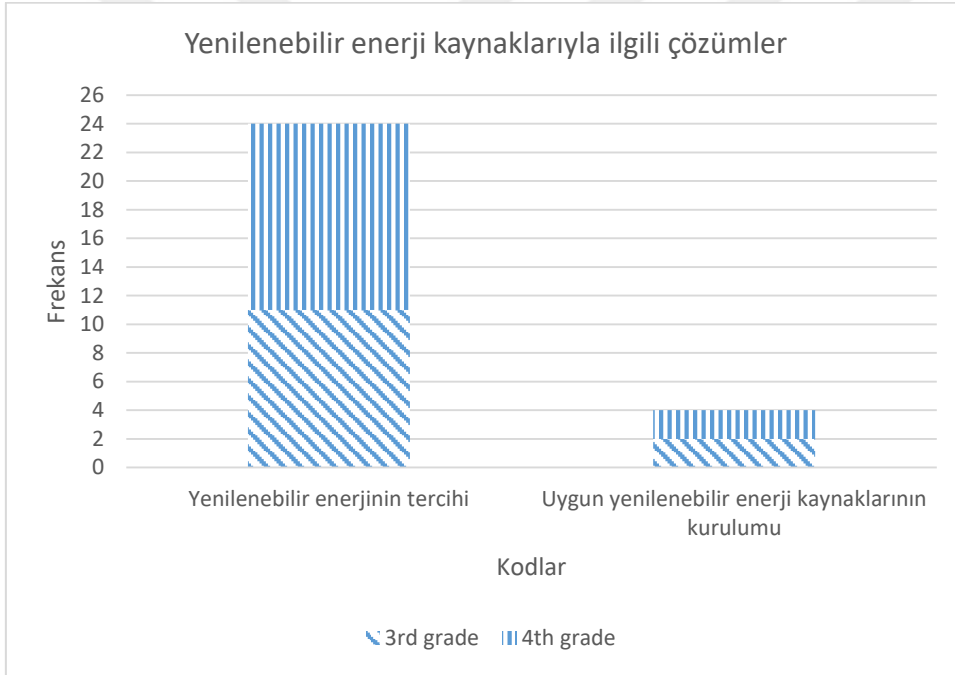
Bulgular, çok az sayıda katılımcının teknolojik gelişime ilişkin çözümlerin farkında olduğunu ortaya koydu. Teknolojiyi içeren çözümler yapısı gereği çok karmaşık olabilir. Bu nedenle, katılımcılar görüşme sırasında bu tür çözümleri düşünmemiş olabilir. Bu çözümden bahseden katılımcı sayısı çok az olduğundan yol modelinde gözlenen ilişkilerde bir rol oynamamış olabilir.

Enerji Kaynaklarıyla İlgili Çözümler

Enerji kaynaklarıyla ilgili çözümlerde iki ana alt kategori ortaya çıkmıştır. Bunlar yenilenebilir enerji kaynakları ve nükleer enerji. Her biriyle ilgili çözüm önerileri aşağıda açıklanmıştır.

Yenilenebilir Enerji Kaynaklarıyla İlgili Çözümler

Şekil 11de gösterildiği gibi, neredeyse tüm PST'ler enerji ile ilgili problemlerin çözümü olarak yenilenebilir enerji kaynaklarından bahsetmiştir. Yenilenebilir enerji türleri açısından en çok bahsedilen güneş enerjisi ve rüzgar enerjisi kaynaklarıdır. Hidroelektrik santralleri ise birkaç katılımcı tarafından çözüm olarak bahsedilmiştir. Bazı katılımcılar, çevreye zarar verdikleri için hidroelektrik santrallerini yenilenebilir enerji türü olarak sınıflandırmadıklarını vurgulamışlardır. Bu katılımcılar yenilenebilir enerji kaynaklarının sınıflandırılması konusunda kavram yanılgısına sahip olabilirler.

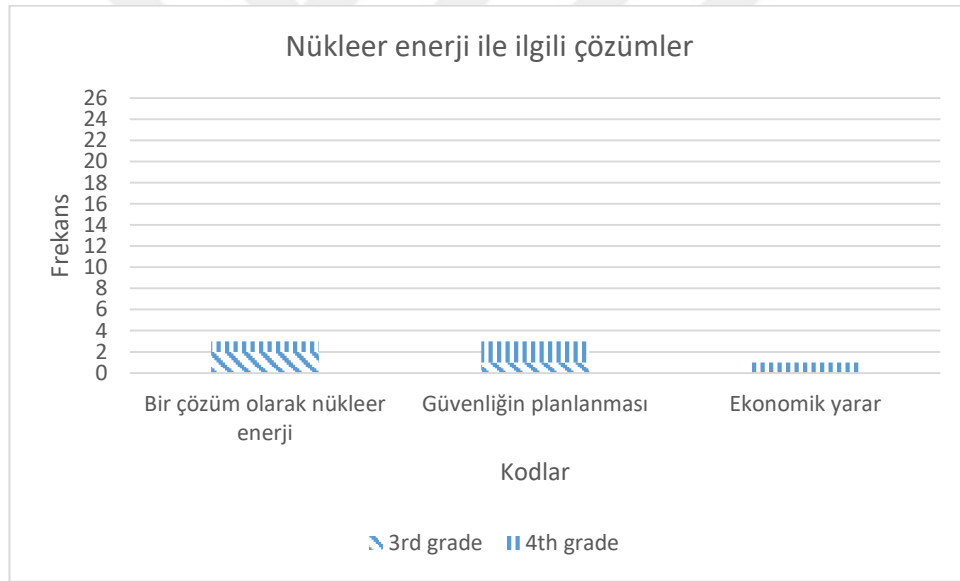


Şekil 11 Sınıf düzeyinde yenilenebilir enerji kaynakları ile ilgili çözümlerin frekansları

Yenilenebilir enerjiye ek olarak, katılımcıların azınlığı, uygun türde yenilenebilir enerji kaynağı kullanmanın önemine işaret etti. Bu katılımcılar, enerji sorunlarına çözüm üretmede yerel özelliklerin rolünü vurguladı. Bu koddan bahseden fen bilgisi öğretmen adayının sayısı çok azdı.

Nükleer Enerji ile İlgili Çözümler

Analizde üç ana kategori ortaya çıkmıştır: (a) bir çözüm olarak nükleer enerji, (b) güvenliğin planlanması ve (c) ekonomik yararlar. Katılımcıların çoğunluğu enerji ile ilgili problemlerin çözümü olarak nükleer enerjiyi önermiyordu, ancak bir kısmı nükleer enerjinin bir çözüm olabileceğini düşünüyordu. Bu nedenle, katılımcılardan kaçının bu enerji türünü bir çözüm olarak gördüğünü belirtmek için, ayrı bir kod oluşturulmuştur. Elde edilen sonuçlar Şekil 12’de gösterilmiştir. Bu kategori altında elde edilen frekans değerleri düşük olduğundan, modelde yer alan ilişkiler bu farkındalıktan etkilenmemiş olabilir.



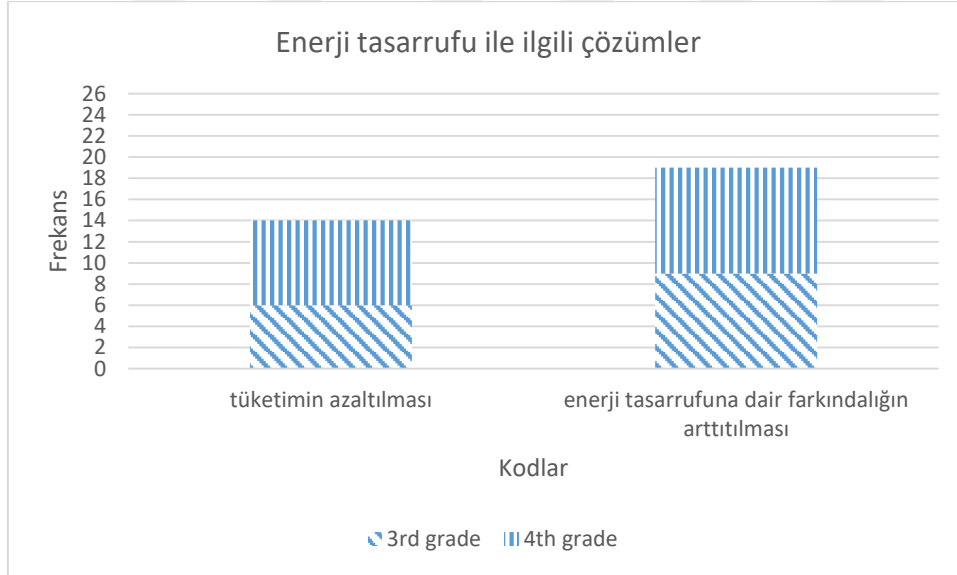
Şekil 12 Sınıf düzeyinde nükleer enerji ile ilgili çözümlerin frekansları

Enerji Tasarrufu ile İlgili Çözümler

İki ana kod ortaya çıkmıştır: (a) tüketimin azaltılması ve (b) enerji tasarrufu konusundaki farkındalığın artırılması. Kodların frekansları Şekil 13’de gösterilmektedir.

Sonuçlar, katılımcıların yarısının, tüketimin bir çözüm olarak düşürülmesinden söz ettiğini ortaya koydu. Bu kapsamda çoğunlukla elektrik kullanımının

azaltılmasını belirttiler. Katılımcıların bir kısmı da bu kapsamda çözüm olarak yerel gıdaların kullanımından, petrol tüketiminin azaltılmasından ve evlerde ısınma ile ilgili tasarruf kapsamında alınabilecek tedbirlerden bahsetti. Bilinçlendirme açısından, katılımcıların çoğunluğu bir çözüm olarak enerji tasarrufu konusundaki farkındalığın artırılmasından bahsetmiştir (bkz. Şekil 13). Tüketicinin azaltılması konusunda farkındalığa sahip olmak fen bilgisi öğretmen adaylarının enerji tasarrufunu içselleştirmesine yardımcı olmuş olabilir ve enerji tasarrufu davranışını daha fazla göstermelerine yol açabilir. Bu da, özerk benlik motivasyonu ile fiziksel davranış arasındaki ilişkiyi güçlendirmede rol oynamış olabilir.



Şekil 13 Sınıf düzeyinde enerji tasarrufu ile ilgili çözümlerin frekansları

Çevreci Bakış Açısı

Bu kategoride katılımcılar, sürdürülebilir bir dünya için enerji sorunlarına çözüm bulunmasının çevreci bir dünya görüşünün benimsenmesine dayandığını belirtmişlerdir. Bu çözüm, bir makro çözüm önerisi olup, bunu belirten katılımcıların sürdürülebilir bir bakış açısına sahip olduğunu ve enerji ile ilgili problemlere karşı bütünsel bir yaklaşım benimsediklerini gösteriyor olabilir.

Sonuçlar, katılımcıların çok azının bu çözüm önerisinden bahsettiğini göstermiştir. Bu sebeple, bu farkındalığın modelde yer alan ilişkiler üzerinde bir etkisi olmayabilir.

Tartışma ve Sonuç

Fen Bilgisi öğretmen adaylarının enerji tasarrufuna karşı tutumu oldukça yüksek çıkmıştır. Bu sonuç, alanyazındaki pek çok çalışma ile benzerlik göstermektedir (örn., Abrahamse & Steg, 2009; Martinsson ve diğerleri, 2011; Şahin, 2013). Bu sonuç başlıca üç sebeple açıklanabilir: (1) eğitim durumu, (2) katılımcıların yaşı ve (3) katılımcıların çevre eğitimi ile ilgili aldıkları dersler. Bazı araştırmalar (ör., Mills & Schleich, 2012; Torgler & Garci'a-Valinas, 2007), yüksek eğitim düzeyine sahip kişilerin, düşük eğitim düzeyine sahip insanlara göre daha fazla enerji tasarrufu tutumu olduğunu gösterdi. Aynı şekilde, katılımcıların yaşı tutumlarında rol oynayabilir. Yani, gençler ve orta yaşlı insanlar enerji tasarrufuna karşı daha olumlu bir tutuma sahiptir (Mills & Schleich, 2012). Bu. Barata, Castro ve Martins-Loução'nun (2016) çalışması da sunulan üçüncü sebebi desteklemektedir. Yaptıkları çalışma göstermiştir, çevre eğitimi dersini alan katılımcıların, çevre eğitimi almayan katılımcılara göre enerji tasarrufuna yönelik tutumlarının çok daha fazla olduğunu ortaya koydu. Çalışmada yer alan katılımcıların da çevre eğitimi ile ilgili aldıkları ders(ler) bu tutumda rol oynamış olabilir. Tutum ve davranış arasında bulunan düşük korelasyon da, pek çok çalışma ile paralellik göstermektedir (Örn, Abrahamse & Steg, 2009).

Enerji tasarrufuna yönelik temel psikolojik ihtiyaçlar bakımından elde edilen sonuçlar katılımcıların enerji tasarrufunu istekli olarak yaptıkları ve bu konuda kendilerini yeterli hissettiklerini göstermiştir. Ayrıca bu davranış açısından içinde bulundukları toplumla ilişkili olduklarını hissettikleri ortaya çıkmıştır.

Öğrencilerin üniversitede aldıkları çevre dersleri bu ihtiyaçları karşılıyor olabilir (örn., Darner, 2012; Karaarslan ve diğerleri, 2014; Karpudedewan ve ark., 2017). Buna ek olarak, bu sonuçta ailelerinin rolü de olabilir. Aileleri enerji tasarrufuna önem veriyor olabilir ve katılımcıların bu davranışları aile tarafından desteklenmiş

olabilir. Ayrıca, temel psikolojik ihtiyaçlar ile enerji tasarrufu davranış türlerinin ilişkili olduğu ortaya çıkmıştır. Bu sonuç alan yazında yer alan çalışmalarla benzerlik göstermektedir (Cooke ve ark., 2016; Sweeney ve ark., 2014)

Motivasyon türleri ile enerji tasarrufu davranış türleri arasındaki ilişki farklılık göstermiştir. Örneğin özerk benlik motivasyonu ile fiziksel davranış arasında orta düzeyde bir ilişki bulunmuşken, özerk benlik motivasyonu ile ikna edici davranış arasında zayıf bir ilişki bulunmuştur. Bu sonuçta fen bilgisi öğretmen adaylarının enerji ile ilgili problemler hakkındaki farkındalıkları rol oynamış olabilir.

Katılımcıların çoğunluğu, enerji ile ilgili sorunların boyutunun (örn. Politika, enerji kaynaklarının etkileri) farkında olmamasına karşın, çoğunluk enerji tasarrufu ile ilgili sorunların farkındaydı (yani, enerjinin boşa gitmesi ve kullanılmaması koruma). Bu farkındalık, özerk benlik motivasyonu ve fiziksel davranış arasındaki görece yüksek ilişkiyi açıklayabilir. Ayrıca, enerji tasarrufu ile ilgili sorunların farkındalığı, katılımcıların fiziksel davranışını içselleştirmelerine yardımcı olmuş olabilir. Bu argüman Ryan ve Deci (2017) tarafından desteklenmektedir. Buna paralel olarak, bu problemler hakkındaki farkındalık temel psikolojik ihtiyaçların karşılanmasına da yardımcı olabilir ve bu şekilde insanlar bazı davranışları içselleştirebilir. Benzer bir şekilde, bazı çalışmalar bu iki değişken arasındaki ilişkiyi çevre dostu davranışlar ve farkındalık açısından desteklemiştir (örn., Pelletier ve diğerleri, 1998).

APPENDIX P. CURRICULUM VITAE

PERSONAL INFORMATION

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Marital Status: Married
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EDUCATION

Degree	Institution	Year of Graduation
MS	METU Elementary Science and Mathematics Education	2011
BS	SDÜ Elementary Science Education	2006
High School	Antalya Karatay Süper Lisesi	2002

WORK EXPERIENCE

Year	Place	Enrollment
2008- Present	METU-Elementary Education	Research Assistant

FOREIGN LANGUAGES

Advanced English

PUBLICATIONS

JOURNAL ARTICLES

Çakır, B., Karaarslan, G., Şahin, E. & Ertepinar, H. (2015). Doğaya Bağlılık Ölçeğinin Türkçe'ye Adaptasyonu. *İlköğretim Online*, 14(4), 1370- 1383.

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INTERNATIONAL CONFERENCE PAPERS

Yilmaz-Tuzun, O., **Çakır, B.**, & Ozturk, N. (2015, June). STEM Integration into a Labortaory Course: A case study. Poster presented at ISER 2015 World Conference of Education, Istanbul-Turkey.

Çakır, B. & Yılmaz-Tüzün, Ö. (2015, April). *Modeling The Relationships Among Pre Service Science Teachers' Cultural Environmental Bias, Nature Relatedness And Energy Related Behaviors*. National Association for Research in Science Teaching (NARST), Chicago, IL, USA.

Çakır, B. (2012, October). *Self Efficacy, Percived Parent & Teacher Goal Orientation As Predictors Of Students' Goal Orientation in Science Learning*. 9th International Conference on Hands on Science, Antalya, Turkey.

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Çakır, B., Ertepinar, H., & Yılmaz-Tüzün, Ö. (2012, March). *Development of Pre-service Science Teachers' Metacognition in an Inquiry Based Laboratory Course*. National Association for Research in Science Teaching (NARST),Indianapolis, IN, USA.

Karaarslan, G., **Çakır, B.**, Şahin, E., Ertepinar, H., & Oktay, Ö. (2012, March). *Which one predict university students' pro-environmental behavior more? Nature relatedness or environmental motive concern?*. National Association for Research in Science Teaching (NARST),Indianapolis, IN, USA.

Çakır, B., Karaarslan, G., Şahin, E., & Ertepinar, H. (2011, September). *Predicting university students' environmental behavior via nature relatedness, environmental concern and environmentally desirable response variables*. The European Conference on Educational Research (ECER), Berlin, Germany.

Karaarslan, G., **Çakır, B.**, Şahin, E., & Ertepinar H. (20011, April). *Relationship among university students' pro-environmental behavior, nature relatedness and*

environmental environmental concern. International Conference On New Trends In Education And Their Implications (ICONTE), Antalya, TURKEY.

Çakır, B., Ertepinar H., & Yılmaz-Tüzün.Ö (2011, April). *A study on a metacognitively oriented learning environment in a science laboratory course.* National Association for Research in Science Teaching (NARST), Orlando, USA.

Çakır, B., Ertepinar H., & Yılmaz-Tüzün.Ö (2010, August). *Use of metacognitive prompts for young experiment in a science laboratory course.* European Educational Research Association (EERA), Helsinki, Finland.

Çakır, B., Ertepinar, H., & Yılmaz-Tüzün, Ö. (2010, June). *Usage of metacognitive prompts in a science laboratory course.* The XIV International Organization for Science and Technology Education Symposium (IOSTE), Bled, SLOVENIA.

NATIONAL CONFERENCE PAPERS

Karaarslan, G., **Çakır, B.**, Ertepinar, H., & Şahin, E. (2010, Eylül). *Eğitim fakültesi öğrencilerinin doğaya bağlılıkları ve çevre dostu davranışları.* Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi, İzmir, Türkiye

Kapucu, S., Yerdelen, S., **Çakır, B.**, Karaarslan, G., & Demir, T. (2014, Eylül). *Doğu Anadolu Bölgesinde Fen Bilgisi Öğretmen Adaylarının Çevre Dostu Davranışları, Tutumları ve Kaygıları.* Ulusal Fen Bilimleri ve Matematik Eğitimi Kongresi, Adana, Türkiye

PROJECTS

Üniversite Öğrencilerinin Sürdürülebilirlik ve Çevre ile İlgili Anlayış, Tutum, Değer, İlgi ve Davranışları Üzerine Bir Çalışma, Araştırmacı, ODTÜ BAP-05-06-2010-01, 2010-2011

Öğretmen adaylarının teknoloji entegrasyon, fen teknoloji mühendislik matematik (FTMM-STEM) yaklaşımı ve sosyobilimsel konuları öğretmeye yönelik algılarının incelenmesi, Araştırmacı, ODTÜ BAP-05-06-2015-002, 2015

COURSES ASSISTED

ELE 331 Laboratory Applications in Science-I
ELE 332 Laboratory Applications in Science-II (STEM oriented)
ELE 343 Methods of Teaching Sciences-II
ELE 420 School Experience
ELE 474 Education and Awareness for Sustainability
ELE477 Laboratory Applications in Environmental Education
ESME 509 Educational Inquiry
ELE 605 Qualitative Research Method
ELE 475 Climate Change Education for Sustainability
ESME 543 Skills on Environmental Issue Investigation
ELE 440 Science Technology and Society

AWARDS & SCHOLARSHIPS

European Educational Research Association (EERA) – ECER 2011 Conference Bursary for Emerging Researchers

Scientific and Technological Research Council of Turkey (TUBITAK) – Scholarships for Master's and Doctorate degrees (2008 to present)

HOBBIES

Scuba-diving, Birdwatching, Cycling

APPENDIX Q. TEZ FOTOKOPİSİ İZİN FORMU

ENSTİTÜ

Fen Bilimleri Enstitüsü ☐

Sosyal Bilimler Enstitüsü ☒

Uygulamalı Matematik Enstitüsü ☐

Enformatik Enstitüsü ☐

Deniz Bilimleri Enstitüsü ☐

YAZARIN

Soyadı : Çakır Yıldırım
Adı : Birgül
Bölümü : İlköğretim

TEZİN ADI (İngilizce) : Exploring preservice science teachers' energy conservation behavior through motivation, psychological needs and attitude: further supported with their awareness

TEZİN TÜRÜ : Yüksek Lisans ☐

Doktora



1. Tezimin tamamından kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
2. Tezimin içindekiler sayfası, özet, indeks sayfalarından ve/veya bir bölümünden kaynak gösterilmek şartıyla fotokopi alınabilir. ☐
3. Tezimden bir bir (1) yıl süreyle fotokopi alınamaz. ☒

TEZİN KÜTÜPHANEYE TESLİM TARİHİ