Cognitive structures of university students about environmental education, climate change and consumption concepts

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Contents

Abstract

The purpose of this study was to determine cognitive structures and the retention of knowledge about environmental education, climate change and consumption

concepts. The field of Environmental Education is increasingly including both climate change and consumption in the context of sustainability. Thus, this research is investigating the construction of cognitive structures using all three concepts. The study group consisted of 52 students (28 females and 24 males) attending the University of Minnesota Duluth, USA. A word association instrument was used for data collection. In order to evaluate the study results, the responses given about the key concepts were examined in detail. A frequency table was constructed to show which words or concepts best represented each key concept included in the instrument. Based on our findings, a frequency table and associated concept maps were generated to indicate how cognitive structures were formed about the three concepts. The findings showed that respondents generated many ideas related to the key concepts presented in the instrument. However, respondents did not appear to see the broad environmental concepts as a network of related ideas. Implications for using the word association test in the classroom are discussed.

Keywords: Word association test, environmental education, climate change, consumption

Introduction

Greenhouse gas emissions, a major cause of global climate change, have reached unprecedented levels since the pre-industrial age (IPCC, 2007). Although Americans comprise less than 5% of the world's population, their contribution to greenhouse gas emissions is almost one-fifth of the global output (World Resources Report, 2010-2011). Educating new generations that will be impacted even more acutely by changing climate patterns, about the impacts of climate change and its sources is therefore critically important to teach about (Boyes, Chuckran & Stanisstreet, 1993; Bofferding & Kloser, 2015). In today's world where global environmental problems are rapidly growing, carbon emissions have already reached the highest known levels and the global ecologic footprint has now reached the top of the loading capacity of the earth. This makes environmental education of even greater importance as a vehicle to provide education about these problems.

The growing impacts of environmental degradation are widely understood to feed expressions of concern about the sustainability of contemporary lifestyles and their impacts on the planet. However, while many environmental problems are increasingly studied in terms of the globalized nature of their origins and outcomes,

the extent of their impacts and associated concerns about their nature are not always examined at the local or immediate level, including aspects of personal experience and perceptions (Kim, 2011).

The failure for students to make the connection between consumerism and environmental problems is often attributed to an inadequacy of environmental education indicating the need to strengthen the focus of environmental education toward earth issues in order to create more effective solutions to contemporary environmental problems (e.g. climate change and personal consumption of non-reusable and or recyclable products) (Benn, 2004; Kagawa, 2007; Boyes, Skamp & Stanisstreet, 2008).

Environmental education involves a multidisciplinary approach of teaching and learning that educates individuals to become more knowledgeable about the natural environment and to develop responsible environmental behavior and skills in order to work for improved environmental quality (Belgrade Charter, 1975; Nordström, 2008; Blanchet-Cohen & Reilly, 2013). Environmental education is assumed to have a significant influence on environmental awareness, everyday lifestyles, and consumer behaviors of students.

Environmental education (EE) and education for sustainable development (ESD) are rising topics on national and international agendas (Pauw, 2014). Among educational content for sustainable development lie key issues such as climate change, the over-use of natural resources, social justice, human rights and democracy. Both EE and ESD allow for students to gain competence to act in the future and within the vision of action competence (Hines, Hungerford & Tomera, 1986; Hasslöf & Malmberg, 2015). Several higher education institutions have recently recognized the importance of integrating sustainability issues into education to make this impact focused and explicit. As a topic, it has emerged as being a field of inquiry seeking to understand how sustainability may be advanced in the curricula and operational activities of higher education institutions (Zsóka, Marjainé, Széchy & Kocsis, 2013; Lozano, 2010; Waas, Verbruggen & Wright, 2010; AASHE, 2014).

Unfortunately, college students have exhibited misconceptions about environmental education, climate change and consumption. This study attempted to offer some insights into these issues. There are several methods to externalize and to measure the cognitive structure of students as the organization and relationships between the concepts in the mind. Research on conceptual change has been a central topic in

science education literature for the last 25 years. It builds from the insight that learners bring their own conceptions of the natural world into the science classroom, which is often incongruent with scientific ones (Bevir, 2003; Hayes, Foster & Gadd, 2003; Kang, Scharmann & Noh, 2004). Students should strive to replace and re-organize their personal concepts of the natural environment through structured lessons by experiencing learning as a process of conceptual change (Abd-el-Khalick & Akerson, 2004; Merenluoto & Lehtinen, 2004). Word associations are one of the methods used for the evaluation of conceptual structures, as well as for ascertaining belief or attitude changes in psychology and sociology (Doise et al., 1993; Hirsh & Tree, 2001; Schmitt, 1998; Hovardas & Korfiatis, 2006). A word association test is one of the most common and oldest methods for investigating cognitive structure, and have been used by several researchers on various subjects (Bahar, Johnstone & Sutcliffe, 1999; Little & Hart, 2016; Derman & Eilks, 2016; Keskin & Örgün, 2015; Öner Armağan, 2015; Aydın, 2015; Aydın & Taşar, 2010; Ercan, Taşdere & Ercan, 2010; Uzun, Özsoy & Keleş, 2010; Nakiboğlu, 2008; Bahar & Özatli, 2003; Bahar et al., 1999; Bahar & Hansell, 2000; Cardellini & Bahar, 2000, Shavelson, 1974).

The method is based on the assumption that giving a stimulus word and asking the respondent to freely associate what ideas come to their mind gives relatively unrestricted access to mental representations of the stimulus term. It has been found that ideas expressed within a word association procedure are spontaneous productions that are subjected to fewer constraints than typically imposed in interviews or written questionnaires and thus allowing less biased results (Wagner et al., 1996).

We used a word association test to map the cognitive structure of environmental education, climate change and consumer consumption to university students at the University of Minnesota Duluth, U.S.A.

Within the scope of environmental education courses given in undergraduate and graduate programs, students have cognitive knowledge about environmental education. Within the scope of education for sustainable development, environmental problems for sustainable life should be examined not only from environmental dimension but also from economic and social dimensions. Unsustainable consumption behaviour causes climate change. Increasing individual awareness of climate change is possible through environmental education. In the context of cognitive, emotional and psychomotor skills, the concept of

environmental education, together with the concepts of climate change and consumption, is important only in the cognitive dimension, in order to reveal the cognitive subset of these concepts in the minds of the students. Therefore, these three concepts are key words related to each other. There have been no direct studies of environmental education-climate change-consumption in the literature. In this research, in order to reveal the cognitive structures of the students participating in the research in the aspect of environmental dimension, the social dimension of climate change, and consumption in sustainable consumption habits in the aspect of these three components of sustainable development, environmental education was chosen.

The purpose of this study was to identify the relationship between university students' cognitive structures about environmental topics, and to guide students to see this map as a reminder of the conceptual environmental links between their word associations and environmental issues. Accordingly, our goal was to find an answer to the following research questions:

1. What is the total number of response words related to key concepts (environmental education, climate change and consumption) in the word association test?
2. What are the three response words that most frequently come to the minds of the respondents in association with each key concept in the word association test?
3. What is the relationship between selected university students' cognitive structures about environmental education, climate change and consumption concepts?

This study is significant because it reveals what the selected student’s conceptual knowledge is toward environmental concepts and issues. It also is intended to serve as a guide to teachers for an additional means of measuring students learning of environmental concepts. This approach has been successful in several other disciplines at varying grade levels, yet it has not yet been used to assess college students’ conceptual knowledge and the subsequent concept mapping of their knowledge about environmental issues and how their own behavior can influence those issues.

Methods

We attempted to identify university students’ cognitive structures about environmental education, climate change and consumption concepts. We utilized

qualitative data collection of Environmental Education (EE) majors, and of students not in the EE major. Qualitative data deals with meanings, whereas quantitative data deals with numbers. The findings from qualitative studies can provide a rich quality of results that quantitative data cannot (Miles & Huberman, 1994).

Participants

The sample size consisted of 52 (28 females and 24 males) and was comprised of two groups of students who were attending two different sections of the same course about a general introduction to outdoor education. Both groups were in their first or second year of study. The students were attending the University of Minnesota Duluth, U.S.A. during the fall term 2013. Out of the participants, 24 (12 females and 12 males) were outdoor & environmental education majors and 28 students (16 females, 12 males) were from various majors such as finance, criminology, political sciences, environment & sustainability, statistics, math, communication, and biology. Since this was a general introductory course, students from different majors were mixed within both sections. The study groups were a convenience sample and were chosen because of the course topic and were assumed to be similar in their knowledge about the environment.

Data Collection Instrument

The word association test (the organization and relationships between the concepts in the mind) was used to determine what concepts the students associated with the key concepts they were provided about environmental education, climate change and consumer consumption to disclose the their personal concept map which indicated their current understanding of the primary environmental concept being provided. The word association test is a data collection technique that is used to analyze the conceptual structure of an individual or a group of people about a certain subject. The technique is based on the assumption that giving a stimulus word and asking the respondents to freely associate what ideas come to their mind gives relatively unrestricted access to mental representations of the stimulus term (Bahar, Johnstone & Sutcliffe, 1999; Hovardas & Korfiatis, 2006; Sato & James, 1999). In the simplest form of this technique, a word or a series of words are presented to participants either in written form or orally. The participants were asked to respond by providing whatever came to their minds as response words in association with the stimulus word. After the content was analyzed and the frequency of response words were calculated, it was possible to make conclusions on the associative meanings of

the stimulus word and so to define the conceptual structures of the participants. This kind of application of the free word association task that reveals the associative meanings of various concepts has been used in numerous studies (Sato & James, 1999; Torkar & Bajd, 2006; Dikmenli, 2010). This methodis a reliable technique used as a procedure for measuring the number, direction and strength of connections (Nelson, McEvoy & Schreiber, 1998; Novak & Govin, 1984; Mervis & Rosh, 1981). When scoring, we counted the same associated words between two concepts and then calculated the ratio of the same associated words to the maximum words in the association. Using sentences/phrases to determine the concept relatedness ratios between each pair of concepts validated the associated words. The total concept relatedness ratios of different pairs of concepts became the score for this test.

Data Analysis

Data collected from the word association test was analyzed as described above. Response words with the same meanings were categorized together under the heading of the response word with the highest frequency: response words that were used three or less times. Irrelevant words that were not associated with the other words were excluded. The words were categorized using a criterion of semantic relationship. The frequency of the words in each category was calculated. We found that several other studies using this type of data analysis provided reliable results (Sato & James, 1999; Torkar & Bajd, 2006; Dikmenli, 2010; Aydın, 2015).

We used the word association test (WAT) as a data collection instrument. In order to construct the test, three key concepts were selected. A sample WAT page is as follows:

Environmental education……..
Environmental education …….
Environmental education ……..
Environmental education ……..
Environmental education ……..
Environmental education ……..
Environmental education ……..
Environmental education ……..
Environmental education ……..

First, the participants were informed about the word association test. For each key concept in the test, the students were requested to write the concepts that came to mind in the relevant gaps. They were asked to use environmental education, climate change and consumer consumption as key concepts while they were working on the association task. They were allocated 30 seconds for each gap. According to Bahar et al. (1999), 30 seconds is the optimum response time period used in many academic studies. We checked the time constantly and guided the participants accordingly. At the end of each 30-second time period, the participants were asked to proceed to the next key concept. Following the administration of the test, the results were assessed through a cut-off point, a technique used by Bahar et al. (1999). During the assessment process, the first step was to calculate the frequencies of the concepts for each key concept provided by the respondents. Second, a frequency table was prepared. Third, by using the frequency table, a concept map was developed. To draw a concept map, the highest frequency in the table was identified and three to five frequencies below the highest frequency were accepted as the cut-off point. The cut-off points were lowered step by step. The concept maps were formed in accordance with the cut-off points determined through frequency ranges. Thus, a concept map constructed for the first breakpoint set the starting point of the next concept map to be constructed. In other words, concept maps tended to be constructed as attached to each other when there were fewer breakpoints. The next step was to consider the total number of answers provided by the respondents for each key concept (Shavelson, 1974).

Findings

Table 1 shows the numbers of the response words produced for each key concept in the word association test.

Table 1. *Number of response words given to environment-related key concepts*

Key Concepts	The Number of Words
Environmental Education	142
Climate Change	112
Consumption	85
Total	339

The total number of response words related to key concepts in the test was found to be 142 for environmental education, 112 for climate change and 85 for consumption.

Table 2 shows the three response words that most frequently came to the minds of the respondents in association with each key concept in the word association test.

Table 2. *Three response words that most frequently came to the minds of the respondents in association with the key concepts in the word association test*

Key Concepts	**The Response Words Produced for Key Concepts**		
	1	2	3
Environmental Education	outdoors	sustainability	nature
Climate Change	global warming	green house gases	ice-caps melting
Consumption	*America	humans	waste

**Note:* "America" was chosen since the study occurred in the United States

As can be seen in Table 2, students frequently used the words of *outdoors*, *sustainability* and *nature* in relation to environmental education, the words of *global warming*, *greenhouse gases* and *melting ice caps* in relation to climate change, and the words of *America*, *humans* and *waste* in relation to consumption.

The concept maps were formed separately for the respondents by their cognitive structures. The concept maps formed in reference to the cut-off points are presented below. The first cut-off point was 19 and above for the concept map formed in reference to the frequencies of the concepts that were provided by the respondents in the word association test. Next, the cut-off point was decreased by five frequencies in a repeated way to develop the other concept maps. The concept maps formed in reference to these cut-off points are presented below. The key concepts and concept map of the associated words constructed based on the results of the word association test and the comments on this map are provided in Figure 1.

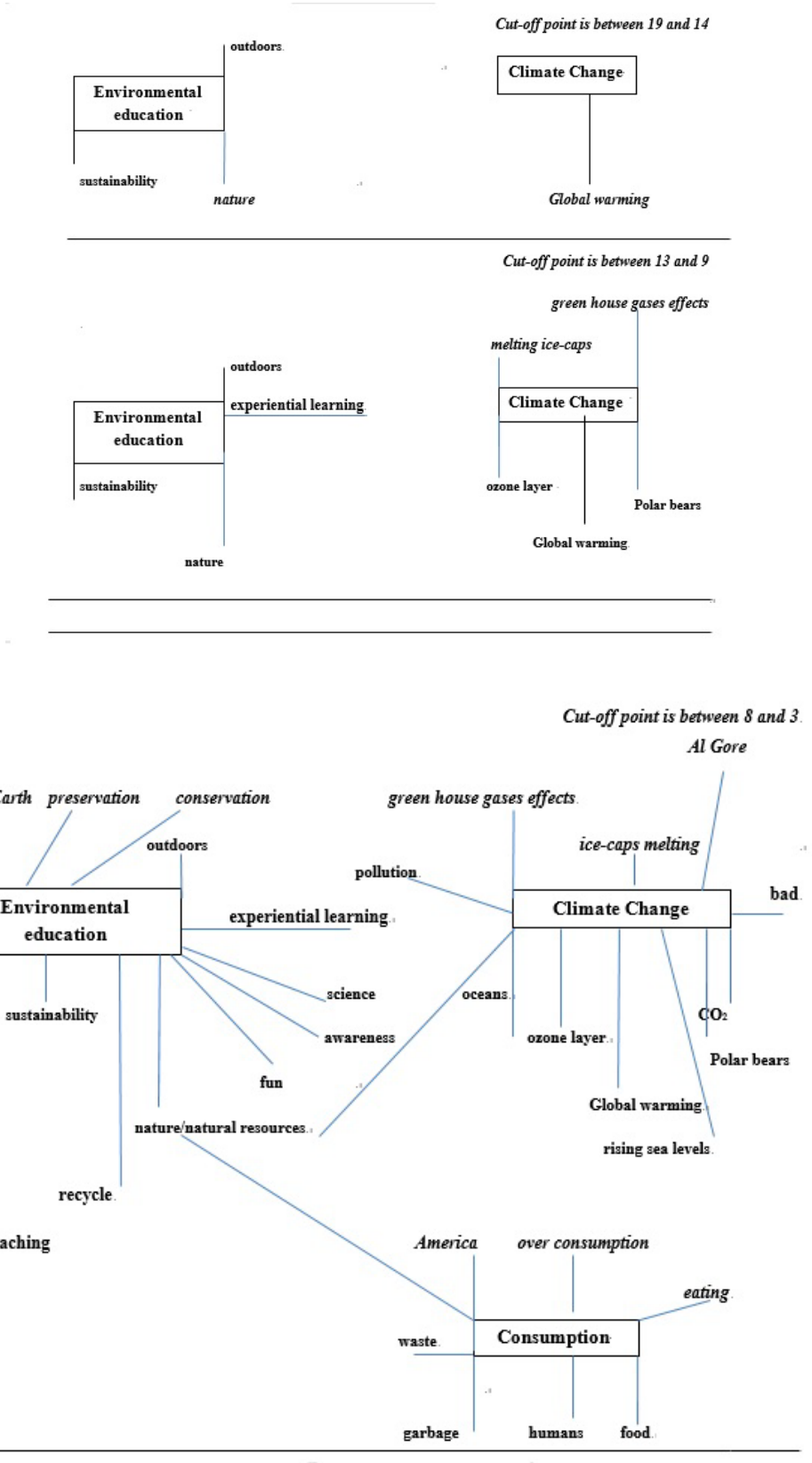

Figure 1. The concept map constructed based on the key concepts

When the results in Figure 1 were examined, there was a considerable increase in the number of both the key concepts and the number of the words associated with the key concepts for the cut-point between 8 and 3. All of the key concepts that were given to the respondents appeared in this interval. Both the relationship between the key concepts themselves starts to appear and increase in the number of words associated when each concept is observed.

Table 3 presents sample sentences concerning the associations formed among the words perceived by the students' in relation to the key concepts given to the students.

Table 3. *Sample sentences concerning the associations formed among the words perceived by the students in relation to the key concepts given*

Key Concept	Sentences Including Scientific Information
Environmental education	• Environmental education takes place primarily in the outdoors. • Sustainability is a goal or outcome of environmental eduation programs. • Sustainability is an environmental education aspect concerning sense of place in ecology. • Natural resources can be better understood through environmental education. • The most effective environmental education takes place in nature. • Environmental education is a way of preserving what we have. • Environmental education is a good chance of teaching to conservation efforts. • Environmental education is based on experiental learning.
Climate change	• Global warming is affecting our world. • The ice caps are melting and it is affecting wildlife. • People see climate change as part of global warming. • Climate change involves the build-up of excess greenhouse gases. • Another common term of climate change is global warming. • Climate change can be bad if it is a human driven v. a natural process. • Al Gore made a movie about climate change.
Consumption	• America is associated with over-consumption of goods. • Americans are wasteful. • The world is consuming all of the Earth's natural resources. • Food consumption is a difficult thing to control in America. • The greatest consumption is what we eat.

Discussion

In light of the findings, we determined which concepts were associated with the concepts of environmental education, climate change and consumer consumption and how those concepts existed in the cognitive structures of the respondents. The

concept map shows how links between these concepts were formed. We found no difference between the differing majors of the students.

The participants emphasized the concepts of outdoors, nature and sustainability in relation to environmental education. In terms of climate change, they focused on the concept of global warming. The secondary concepts existing in the students' minds in relation to environmental education were experiential learning, ozone layer, polar bears and melting ice caps in relation to climate change. In the section where the cut-off scores of the participating students were between 8 and 3, we observed that the students recalled more concepts associated with the key concept. In this cut-off interval, the students emphasized the concepts such as earth, preservation, conservation, teaching, recycling and awareness in relation to environmental education. They also emphasized the concepts such as rising sea levels, Al Gore, and oceans in relation to climate change. It is remarkable that the students uttered the word "bad" that is related to affective concepts in relation to the concept of climate change. The students emphasized the concepts such as America, waste, garbage, humans, food, eating and over-consumption in relation to the concept of consumer consumption. Another notable finding was that the students did not want to give the name of the country they lived in because of the negative impacts it implies toward consumption.

From the results, word association tests were found to be quite effective in the determination and evaluation of well-constructed and connected information webs in the minds of the students about environment-related concepts. They appear to be a good means of diagnosis.

These findings display similarities with past studies. Bahar, Johnstone & Sutcliffe (1999) administered a word association test to first-year biology students from Glasgow University following instruction in genetics. In that study, by means of the word association test, the students' cognitive structures related to genetics were investigated. It was concluded that many questions in the multiple-choice tests could be good predictors of the relationships between their concepts of genetics. Bahar & Özatlı (2003) administered a word association test in order to investigate high school students' cognitive structures related to the basic constituents of living organisms. The pre-word association test revealed that the preliminary information possessed by the students about the subject was too extensive when including irrelevant concepts. The post-word association test found that the students started to provide more

scientific information. Nakiboğlu (2008) administered a pre-word association test and a post-word association test to pre-service elementary school classroom teachers about the subjects of the structure and theories of the atom. It was concluded that the word-association test could be used as an alternative to more traditional methods in the elicitation of the conceptual organization in knowledge structure. Ercan, Taşdere & Ercan (2010) conducted a study to investigate 7th grade students' cognitive structures and their conceptual transformation process about the subjects of the solar system and space. They found that the conceptual transformation of the students occurred in a positive direction. Uzun, Özsoy & Keleş (2010) employed a word-association test to determine Turkish pre-service teachers' prior knowledge about biological diversity. They found that the pre-service teachers had a limited number of concepts about the subject. Cardellini & Bahar (2000) used a word-association test to map the cognitive structures of first-year university students from the Department of Chemistry Engineering about chemistry. The results of the word-association test administered before and after the instruction revealed that as a result of the instruction, a great increase was observed in the number of the response words associated with the key concepts (reaction, chemical equilibrium, chemical bond, reaction velocity, oxidation-reduction, molecule, solution, physical state and atom). Aydın & Taşar (2010) conducted a study to investigate the pre-service science teachers' cognitive structures and opinions about the nature of technology. They found that the participants' cognitive structures about the nature of technology, information about the definition of technology, mutual interaction between technology and society, and their opinions about the societal structure of technology showed a low level of conceptual knowledge.

Findings reported in the relevant literature reveal that this technique can be used both as a means of diagnosis and a conceptual transformation strategy by academicians and instructors working in science and other disciplines as an alternative to traditional methods (Hovardas & Konstantinos, 2006).

Conclusions and Recommendations

We attempted to identify the cognitive structures of university students about environmental concepts. The results of this study on word-association tests indicates that these tests can be used as an effective technique to determine the knowledge levels of students, their cognitive structures, and to examine students' conceptual

transformation. The most interesting finding was about university student's opinions about Americans food consumption, over-consumption of goods and their negative impacts on the environment. We found that the university students who participated this study were aware of the negative impacts on the world caused by their living habits. These findings suggest that people with high environmental awareness can behave better than those with a low environmental awareness. The findings also indicate that it is necessary to take into account how university students conceptualize global warming and consumer consumption, which are the contemporary subjects of our global world. The word association test is an open-ended test that assesses students' conceptual linking ability and also their accuracy in retrieving relevant knowledge. The word association test can measure learning performance just as well as traditional assessment methods. Apart from providing numerical scores for learning performance, the word association test can also provide teachers with useful qualitative evidence on students' progress with their learning as well as their understanding of concepts. The technical procedures of setting, carrying out and scoring the tests are reasonably easy to handle. On the basis of the evidence shown, we suggest that the word association test should become part of the regular testing of environmental conceptual learning in schools. Based on the results, the following recommendations can be made:

- First, university students can be provided with better training in environmental education when their instructors focus on the cognitive structures about environmental concepts.
- Second, such studies should be taken into account to better train students from primary school through university levels.
- Finally, further studies should focus on different ways to improve university students' cognitive structures about environmental concepts. This technique can be particularly employed by academicians to evaluate students' conceptual level of knowledge about the content of environmental sciences and environmental education courses.

References

Abd-el-Khalick, F., & Akerson, V. L. (2004). Learning as conceptual change: factors mediating the development of preservice elementary teachers' views of nature of science. *Science Education, 88*, 785-810.

Association for the Advancement of Sustainability in Higher Education (AASHE). (2014). 2014 *higher education sustainability review*. Retrieved July 10, 2015: http://www.aashe.org/publications/sustainability-review/2014-Higher-Education-Sustainability-Review

Aydın, F. & Taşar, M. F. (2010). An investigation of pre-service science teachers' cognitive structures and ideas about the nature of technology. *Ahi Evran Ünversitesi Kırşehir Eğitim Fakültesi Dergisi, 11 (4)*, 209-221.

Aydın, F. (2015). The relationship between pre-service science teachers' cognitive styles and their cognitive structures about technology. *Research in Science & Technological Education, 33* (1), 88-110.

Bahar, M. & Özatlı, N. S. (2003). Kelime iletişim test yöntemi ile lise 1. sınıf öğrencilerinin canlıların temel bileşenleri konusundaki bilişsel yapılarının araştırılması. *Balıkesir Üniversitesi Fen Bilimleri Enstitüsü Dergisi, 5*, 75-85.

Bahar, M., and H. M. Hansell. (2000). "The relationship between some psychological factors and their effect on the performance of grid questions and word association tests." *Educational Psychology 20* (3): 349-364.

Bahar, M., Johnstone, A. H. & Sutcliffe, R. G. (1999). Investigation of students' cognitive structure in elementary genetics through word association tests, *Journal of Biological Education, 33(3)*, 134-141.

Benn, J. (2004). Consumer education between "consumership" and citizenship: experiences from studies of young people. *International Journal of Consumer Studies, 28*, 108-116.

Bevir, M. (2003). Notes toward an analysis of conceptual change. *Social Epistemology, 17*, 55-63.

Blanchet-Cohen, N. & Reilly, R. C. (2013). Teachers' perspectives on environmental education in multicultural relations: Towards culturally-responsive environmental education, *Teaching and Teacher Education, 36*, 12-22.

Bofferding, L & Kloser, M. (2015). Middle and high school students' conceptions of climate change mitigation and adaptation strategies. *Environmental Education Research, 21(2)*, 275–294.

Boyes, E., Chuckran, D., & Stanisstreet, M. (1993). How do high school students perceive global climatic change: What are its manifestations? What are its origins? What corrective action can be taken? *Journal of Science Education and Technology 2*(4), 541–557.

Boyes, E., Skamp, K., & Stanisstreet, M., (2008). Australian secondary students' views about global warming: beliefs about actions, and willingness to act. *Research in Science Education 39*, 661-680.

Cardellini, L., & Bahar, M. (2000). Monitoring the learning of chemistry through word association tests. *Australian Chemistry Resource Book, 19*, 59-69.

Derman, A., & Eilks, I. (2016). Using a word association test for the assessment of high school students' cognitive structures on dissolution. *Chemistry Education Research and Practice, 17*, 902-913.

Doise, W., Cle´mence, A., & Lorenzi-Cioldi, F. (1993). The quantitative analysis of social representations. London: Harvester Wheatsheaf.

Ercan, F., Taşdere, A., & Ercan, N. (2010). Kelime ilişkilendirme testi aracılığıyla bilişsel yapının ve kavramsal değişimin gözlenmesi. *Journal of Turkish Science Education, 7*(2), 136-154.

Hasslöf, H., & Malmberg, C. (2015). Critical thinking as room for subjectification in Education for Sustainable Development. *Environmental Education Research, 21*(2), 239–255.

Hayes, B., Foster, K., & Gadd, N. (2003). Prior knowledge and subtyping effects in children's category learning. *Cognition, 88*, 171-199.

Hines, J. M. , Hungerford, H. R., & Tomera, A. N. (1986). Analysis and synthesis of research on responsible environmental behavior: A meta-analysis. *Journal of Environmental Education, 18(2)*, 1-8.

Hirsh, K. W., & Tree, J. J. (2001). Word association norms for two cohorts of British adults. *Journal of Neurolinguistics, 14*, 1-44.

Hovardas, T., & Konstantinos, J. K. (2006). Word associations as a tool for assessing conceptual change in science education. *Learning and Instruction, 16*, 416-432.

IPCC, (2007). 4. Adaptation and Mitigation Options. Climate Change 2007: Synthesis Report. Contribution of Working Groups I, II, III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva: IPCC

Kagawa, F. (2007). Dissonance in students' perceptions of sustainable development and sustainability. *International Journal of Sustainability in Higher Education, 8*, 317-338.

Kang, S., Scharmann, L. C., & Noh, T. (2004). Reexamining the role of cognitive conflict in science concept learning. *Research in Science Education, 34*, 71-96.

Keskin, E, & Örgün, E. (2015). Kelime İlişkilendirme Testi Aracılığıyla Sürdürülebilir Turizm Olgusunun Kavramsal Analizi: Ürgüp Örneği. *Journal of Tourism and Gastronomy Studies, 3(1)*, 30-40.

Kim, M. (2011). Science, technology and the environment: the views of urban children and implications for science and environmental education in Korea. *Environmental Education Research, 17*(2), 261–280.

Lee, Kam-Wah. (1988). Two non-traditional measures of chemistry learning: word associatıon and idea associatıon. *Research In Science Education, 18*, 169-176.

Little, G. W., & Hart, S. A. (2016). Examining the genetic and environmental associations among spelling, reading fluency, reading comprehension and a high stakes reading test in a combined sample of third and fourth grade students. *Learning and Individual Differences, 45*, 25-32.

Lozano, R. (2010). Diffusion of sustainable development in universities' curricula: An empirical example from Cardiff University. *Journal of Cleaner Production, 18*, 637-644.

Merenluoto, K., & Lehtinen, E. (2004). Number concept and conceptual change: towards a systemic model of the processes of change. *Learning and Instruction, 14*, 519-534.

Mervis, C.B. & Rosh, E. (1981). Categorization of natural objects. *Annual Rev. Psychology, 32*, 89-115.

Miles, M. & Huberman, M. (1994). An expanded sourcebook *qualitative data analysis, Second edition*, Beverly Hills CA: Sage.

Nakiboğlu, C. (2008). Using word associations for assessing non major science students' knowledge structure before and after general chemistry instruction: The case of atomic structure. *Chemistry Education Research and Practice, 9*, 309–322.

Nelson, D. L., McEvoy, C. L. & Schreiber, T. A. (1998). The university of South Florida word association, rhyme, and word fragment norms. http://www.usf.edu/FreeAssociation/.

Nordström, H. (2008). Environmental education and multicultural education: Too close to be separate? *International Research in Geographical and Environmental Education, 17*, 131-145.

Novak, J.D. & Govin, D.B. (1984). *Learning how lo learn.* New York: Cambridge University Press.

Öner Armağan, F. (2015). Cognitive Structures of Elementary School Students: What is Science?, *European Journal of Physics Education, 6(2)*, 54-73.

Pauw, J. B. (2014). Moving environmental education forward through evaluation, *Studies in Educational Evaluation, 41*, 1–3.

Sato, M. & James, P. (1999). Nature and environment as perceived by university students and their supervisors, *International Journal of Environmental Education and Information, 18*, 165-172.

Schmitt, N. (1998). Quantifying word association responses: what is native-like? *System, 26*, 389-401.

Shavelson, R. J. (1974). "Methods for examining representations of a Subject-matter Structure in a Student's Memory." *Journal of Research in Science Teaching 11*: 231–249.

Torkar, G. & Bajd, B. (2006). Trainee teachers ‟ ideas about endangered birds, *Journal of Biological Education, 41*, 5-8.

United Nations Educational, Scientific and Cultural Organization (UNESCO). (1975). The Belgrade Charter. *1975 UNESCO conference*. Belgrade, Serbia (formerly Yugoslavia).

Uzun, N., Özsoy, S., & Keleş, Ö. (2010). Öğretmen adaylarının biyolojik çeşitlilik kavramına yönelik görüşleri. *Biyoloji Bilimleri Araştırma Dergisi, 3*(1), 93-99.

Waas, T., Verbruggen, A., & Wright, T. (2010). University research for sustainable development: definition and characteristics explored. *Journal of Cleaner Production, 18*, 629-636.

World Resources Report (2010-2011). Decision making in a changing climate, by United Nations Development Programme, United Nations Environment Programme, World Bank and World Resources Institute, http://pdf.wri.org/world_resources_report_2010-2011.pdf

Zsóka, A., Marjainé, S. Z., Széchy, A., & Kocsis, T. (2013). Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students. *Journal of Cleaner Production, 48*, 126-138.