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A Comparative Study of Science Majors and Non-Majors Prospective Teachers Understanding of Energy Sources for Living Organisms

Sacit Köse
Department of Biology Education, Faculty of Education,
Pamukkale University, 20070, Denizli, Turkey

Abstract: This research has been done in order to determine and to compare the misconceptions of the science majors and nonscience majors prospective teachers in the topics of energy and energy resources. For this aim, a questionnaire-test has been applied to 210 prospective teachers in the first-year the undergraduate programs at the Departments of Elementary Education and Turkish Language Teaching in Pamukkale University in Denizli in Turkey. The results of the findings indicated that two groups of prospective teachers have both similar misconceptions about energy and energy sources. It is obvious that prospective science teachers have higher rates than non-majors prospective teachers in some basic misconceptions. For example, while non-majors prospective teachers have 13% rate in making Plants obtain energy from worms and insects misconceptions, that misconceptions is 34% for prospective science teachers.

Key words: Energy, energy sources, misconception, comparative, non-major, science major

INTRODUCTION

In primary school, science education is a base for students intellectual development. For this reason, it is very important to train the teachers that teach science education. One important factor in meaningful learning the science concepts to a student are misconceptions. It is mentioned that mostly, the teachers have a role in rooting and maintaining the basic misconceptions in students minds (Yip, 1998). In recent years, it is intensified on these misconceptions in the previous studies of science education (Haslam and Treagust, 1987; Barak *et al*., 1999; Kao, 2007; Köse, 2007, 2008).

Energy is one of the most important topics in science education. For example, physics has been unified with energy. All the physics topics can be taught under this topic. In the same way, the energy circle in the nature is an essential topic for biology. Besides, it is related with the fields which are outside of science like technology and economy. Recently, it has taken as the form of socio-economic term. The topics like energy sources, energy circles and renewable energy have been a basic concern for public and governments. But, it has been demonstrated in the researches that there are many difficulties in teaching the energy concept and that student's hold misconceptions. It is claimed that this situation stems from such reasons like the concept's being abstract, the same usage of daily and scientific language and the impossibility for explaining every energy type with a simple language (Boyes and Stanisstreet, 1990, 1991).

Moreover, it is declared that, the difficulty in learning these energy concepts is related to understanding the reason-result relationship, the vague in expression and the disorder on subjects (Özmen *et al*., 2000). For students to learn these concepts meaningfully, it is about to understand the relationships and integrate in various science fields. In physics lessons, energy is mostly taught as mechanical energy, the relationship between job and energy in science, the formation of energy by

chemical reactions and formation of sun energy like nuclear energy in chemistry and the formation of foods by photosynthesis and formation of ATPs by respiration burning these foods in biology. However, these phenomenons are not independent from each other. As a result all these branches must be integrated after teaching the related subjects separately (Gürdal *et al*., 1999).

In Turkey, a subject in the title of energy does not exist on in primary or secondary school education. Energy subject is taught as sub-titles. For this reason, it is indicated that the energy concept differently structure in students' minds and starts difficulties in relating these subjects (Kayalı *et al*., 2000; Ayas *et al*., 2002). This statement is seen as similar by university students (Uşak, 2005; Konuk and Kılıç, 1998).

In a study by Boyes and Stanisstreet (1991), a questionnaire applied to university biology (n = 54) and physics (n = 55) students in first class about the energy sources in plants and animals. As a result, it is seen that biology students have more success than physics students but they have both basic misconceptions about energy sources for in living organisms. In a study by Konuk and Kılıç (1998), a questionnaire about energy in plants and animals applied to Selçuk University Education Faculty, Physics, Chemistry, Biology and Science Education first class students (n = 345). At the end of these applications, it is released that 50% of students coming from high school have wrong knowledge about energy sources in living organisms. Adcock (2003) explored whether making students aware of a major misconception about photosynthesis prior to instruction would provide the dissatisfaction with their current conceptions necessary for helping students to achieve accommodation of new, scientifically more acceptable concepts. Findings indicated that most students were unclear about the energy source for plants. Only 9% of students selected sunlight as the only energy source for plants. Ninety-one percent of students thought that plants obtain energy from sources other than light. In a study by Köse *et al*. (2006) an interview made by former science teachers show that many basic misconceptions in knowledge of energy sources in animals and plants stands.

This study is done to identify and compare the misconceptions about energy and energy sources and applied with prospective teachers from Science, Turkish and Social Sciences Education Teaching in Pamukkale University.

MATERIALS AND METHODS

Instrument

In this study, a questionnaire-test based case study method is used. The questionnaire-test questions are taken from the study by Köse *et al*. (2006). The first two questions are in 5-likert type and include 14 items in multiple-choices type. First question is about where plants get their energy and the second question is about where the animals get their energy. Additionally, both of the questions are formed by seven items.

These items are scaled in five categories as I am sure this is right (A), I think this is right (B), I don't know if this is right (C), I think this is wrong (D) and I am sure this is wrong (E).

The answers of prospective teachers are evaluated as A and B true, C I don't know, D and E wrong. The third question is a two-tier, open ended question and prospective teachers are asked for making choices about which items are energy free and for explaining their answers. The last question is open ended and is prepared for getting the thoughts of prospective teachers about energy.

Participants

The participants for this study were first-year prospective science teachers (Department of Science Teacher Education: n = 100) and nonscience prospective teachers (Department of Turkish Language Teacher Education: n = 54; Department of Social Science Teacher Education: n = 56).

Data Analysis

Every question in the test is separately analyzed and the findings are figured as tables. The open ended questions are analyzed and grouped by their conditions as similarity, differentiation and independency. They are figured in a table with prospective teachers own expressions.

RESULTS

A questionnaire-test with four questions has been carried out for 210 people to be able to determine the misconceptions about energy and energy sources of the prospective teachers who start to study at the departments science and nonscience in education faculty. The answers of the prospective teachers' for the question of Where does the energy that plants use come from? (1st question) have been given in Table 1.

Responses to Question 1 reveal serious deficiencies in the understanding of most prospective teachers. Although 90% of the science majors indicated that plants obtains energy from the sun, only 8% ticked only the sun. On the contrary, 80% non-majors indicated that plants obtain energy from the sun, only 15% ticked only the sun. The others indicated that plants obtain energy from other sources as well, such as water, air, soil and fertilizer. Most prospective teachers ticked two or more choices in addition to sun. Approximately the same rate students (10%) have preferred only the sun choice in the study by Anderson *et al*. (1990). As seen in Table 1, the prospective teachers in both groups have made mistake by preferring the wrong choices; water and soil beside the sun. While the prospective science teachers do not leave the choices blank, the others do not mark the choices at a great rate.

The answers of the prospective teachers for the second question (Where do animals get the energy?) have been given in Table 2.

For the second question of the questionnaire-test; 12% of prospective science majors and 22% of the non-majors mark only the right answer Animals obtain energy from food. The others indicated that animals obtain energy from other sources as well, such as water, air, sun and sleeping. Most prospective teachers ticked two or more choices in addition to food. The same results have been taken from previous studies, too (Anderson *et al*., 1990; Ayas *et al*., 2002). As shown in Table 2, the

Table 1: Percentages of prospective teachers' responses of question 1

	Science majors					Non-majors					
Question 1	A	B	C	D	E	A	B	C	D	E	NA
Air	26	37	20	8	9	39	28	4	4	1	24
Water	45	30	15	10	0	46	26	0	1	0	27
Soil	34	39	17	3	7	40	30	1	0	0	29
Fertilizer	30	28	26	10	6	26	30	4	0	0	39
Sun*	71	19	6	4	0	54	26	3	0	0	17
Wind	5	3	26	38	28	2	3	13	23	12	47
Worms and Insects	13	21	27	19	20	4	9	13	12	15	47

*True answer, NA: No answer

Table 2: Percentages of prospective teachers' responses of question 2

	Science majors					Non-majors					
Question 2	A	B	C	D	E	A	B	C	D	E	NA
Air	22	28	25	13	12	31	21	8	5	0	35
Water	27	32	16	17	8	55	21	3	0	0	21
Food*	86	14	0	0	0	65	27	1	0	0	7
Sun	24	28	27	12	9	28	23	5	2	0	42
Exercise	4	11	37	20	28	4	10	20	13	4	49
Sleeping	18	25	23	19	15	20	26	11	0	0	43
Keeping warm	10	26	38	18	8	7	29	13	7	1	43

*True answer, NA: No answer

Table 3: Percentages of prospective teachers' responses of question 3

		Science majors			Non-majors		
Section	Question 3	T	F	NA	T	F	NA
1st section	Ice cream	96	4	0	93	1	6
	Water*	20	80	0	1	93	6
	Apple	98	2	0	94	0	6
	Phosphorus*	31	69	0	12	82	6
	Oxygen*	29	71	0	1	93	6
	Carbon dioxide*	84	16	0	83	11	6
	Yoghurt	96	4	0	93	1	6
2nd section	Explanation	4	76	20	0	66	34

*True answers, T: True answer, F: False answer, NA: No answer

prospective teachers prefer the choice of water in addition to the right answer. Fifty nine percent of the prospective science teachers and 76% of the others prefer this choice. By preferring the other choices at the same rate hold misconception. While the prospective science majors mark all the choice in this question, the prospective non-majors have left unanswered the question at a great rate.

While the four prospective science teachers answer the third question correctly (Which of this or these cannot we obtain energy? Explain your answer. a. Ice cream b. Water c. Apple d. Phosphorus e. Oxygen f. Carbon dioxide g. Yogurt) none of the nonscience majors answer it correctly.

Most of the prospective teachers either mark one or two of the right answers or prefer in addition to these the other choices with distractors. About 84% of the prospective teachers in both groups do the rights answer of We cannot obtain energy from carbon dioxide. Data has been shown in Table 3.

As shown in Table 3, in the first tier of the third question, the prospective teachers of the both groups hold the misconceptions such as we obtain energy from water, phosphorus, oxygen, carbon dioxide. But it has been found out that the rate of these misconceptions in nonscience majors is higher than others. In addition, it has been found out that some prospective teachers mark these choices by thinking that we can not obtain energy from ice cream, yoghurt and apples.

While four of the prospective science teachers answer the second tier of the question correctly, most of the prospective non-majors' have not answered correctly. It has been found that most of the prospective teachers who have given wrong explanation do not know the functions of the organic and inorganic substances and have misconceptions about that inorganic substance that do not give energy. The prospective teachers have been expected to write the right answer of water, oxygen, phosphorus and carbon dioxide are inorganic substances and do not give energy. Most of the prospective teachers in both groups explain why we cannot obtain energy from carbon dioxide. It has been found that most of those ones who prefer the other choices do not give explanation. Some of the prospective teachers who prefer the choice of carbon dioxide explain the reason of their choice like that carbon dioxide exits as a product from the body; carbon dioxide is a harmful gas; carbon dioxide is for green plants, we cannot use the carbon dioxide. Some of the prospective non-majors explain like that, carbon dioxide is gas that is given out by the plants at nights and harmful for the people, all the other choices include the substances that supply energy for the human body such as calorie and protein; carbon dioxide does not have a situation like that as carbon dioxide is a harmful gas. Carbon dioxide decreases the energy of alive. While the ones of the prospective science teachers choose water choice write an explanation like life cannot be without water; water is an organizer element; as water is used in photosynthesis… A prospective teacher non-major tells Water destroys energy. Some of the prospective science teachers who choose the phosphorus choice explain phosphorous increase the strongest of our bone. Phosphorous puts the light in prison, it is a light energy. Some of the non-majors explain phosphorous does not give energy; it is a substance that is thrown into the fertilizer and it is not an energy source for the people. Some of the prospective science teachers choose the oxygen choice and say life cannot exist without air; oxygen is an element; air is the most important energy source. While the prospective

Table 4: Percentages of prospective teachers' responses of question 4

The opinions of science majors	(%)	The opinions of non-majors	(%)
Alive need energy to sustain their lives.	28	It is the power for alive to remain and to move.	23
Energy is the ability to work.	21	It is the source of alive	15
It has forms in the nature. It is convertible. For example kinetic energy can be converted to potential energy and vice verse.	11	Alive can get the energy from every type of materials in their environment. Everything is energy for them in their area.	5
Energy can not be existed while it is not there and it cannot be disappeared while it is there.	15	It is the power occurred by interaction.	3
It is the force to move something.	3	Energy is a must.	3
It has types as heat, light and nuclear energy.	7	It is a need for alive to produce	2
It has been absorbed by the materials in the world.	1	The continuous and exhausted energy sources are there. The greatest energy source is Sun and other sources take their power from the Sun.	3
It can be released by burning the materials or by busting like the nuclear energy.			3
It exists from breaking phosphate while changing into ATP-ADP by breaking glucose.	1	A power taken from food by alive to live.	11
Energy is a must.	3	All the factor such as power and dynamism to be able to work.	3
It is something human beings get from foods.	2	It is secreted by Mitochondria.	1
Human beings need energy in activities like running and lifting.	1	Power source by the sequence of several minerals.	1
It is the reason of war.	2	It is the power to move a material	1
I don't know.	5	It is something that an alive is more active and more alive.	1
		A basic factor for the metabolism to work.	2
		It is available in the nature and it may be produced by unnatural ways.	2
		Energy can not be existed while it is not there and it cannot be disappeared while it is there.	3
		When people eat food including vitamin the vitamin gives the human the power and the energy.	1
		Energy gives dynamism to human.	
		It has types as sun, electric, wind and water.	6
		It is the power to make life easier. For example, sun energy, water energy.	1
		I don't know anything and blank	13

science teachers who tell that we can not get energy from yoghurt maintain that yoghurt has lactic acid and lactic acid is harmful, some of the prospective non-majors say that yoghurt makes people sleepy and tired. Some of the prospective science teachers maintain that we cannot get energy from apples and ice-cream and explain the reason like this Apple is a vitamin, vitamin does not give energy to human body; we cannot get energy from ice-cream because we take energy from food and hold a misconception. Some of the prospective nonscience majors who choose the ice-cream choice do this explanation: Ice-cream is cold but people are warm blooded.

The answers of the prospective teachers to the question of What do you know about energy? are given in Table 4.

When Table 4 is examined it is seen that 63% of the prospective science teachers explain energy according to the physics, but others (32%) give explanations related with energy in biology. Besides, most of the prospective non-majors' (62%) explain their ideas about energy in biology.

DISCUSSION

After the results of the study were examined it was seen that both science education teaching and some other branches of education prospective teachers at the first year of undergraduate programs at the Educational Faculty of Pamukkale University have misconceptions in energy and energy sources.

According to biological theory, plants obtain metabolic energy from only one source: sunlight. Animals obtain metabolic energy only as chemical potential energy in food. But both science and

nonscience prospective teachers though the substances vital for gaining energy as the sources of energy. We are behind the problem that prospective teachers confuse the role of materials and the energy sources.

We were shocked as we see both groups of prospective teachers have similar misconceptions. Moreover science education teachers had more misconceptions in some bases. In Turkish Education System, students choose science or other branches such as Turkish-Mathematic or Social Sciences in high school, in second class and the other branches do not take any science lessons any more. Study results should be vice versa because science classes in second and third class in high school take intense science programs.

It has been seen that there is a misconception as Plants supply their energy by photosynthesis both in the studies taken in native country and in foreign countries (Anderson *et al*., 1990; Hill, 1997; Griffard and Wandersee, 2001; Adcock, 2003; Köse, 2004; Marmaroti and Galanopoulou, 2006; Çepni *et al*., 2006). It has been thought that, this type of misconception enable the misconceptions such as the materials that are used in making organic substances by photosynthesis are believed to be the energy sources. Additionally, the though for vital materials to produce food as food for plants, the lacking in the knowledge of fertilizers, to understand the conversion of energy and other misconceptions would be caused by the belief that plants feed like animals and human beings.

In animals, the need for the oxygen in water and air to burn the organic molecules would cause similar misconceptions. In addition, the dynamism of the animal after it sleeps can be misconception. This misconception can be seen in the previous studies too (Boyes and Stanisstreet, 1990; Mikkilä-Erdmann, 2000; Köse *et al*., 2006).

However, it has been seen that prospective teachers have the belief that water, phosphorous, oxygen and CO_2 are inorganic substances and we can get energy from an inorganic substances. Similar misconceptions had been seen in all the student levels from primary school to university (Hill, 1997; Özay and Öztaş, 2003; Kose and Usak, 2006). This statement indicates that there can be a lacking in students knowledge of the description of organic and inorganic molecules and energy capacities (Uşak, 2005).

If we examine the answers of the question what is energy, we can see that, prospective science teachers intensify on the energy in physics and prospective non-majors intensify on the energy in biology. If we consider that energy is multidisciplinary as environment, the integration of this subject for all branches must be done to contribute the entirety in education.

It has been seen that prospective teachers studying in university continue their misconceptions which they got in primary and high school. In a study by Diakidoy *et al*. (2003), which aimed to determine the knowledge of primary school students in energy concept, it has fixed that conceptual change text facilitate the conceptual understanding. To determine and overcome the misconceptions of prospective teachers about energy and energy sources, a study should be applied.

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REFERENCES

Adcock, B.C., 2003. Examining the impact of directly addressing a major misconception about photosynthesis prior to instruction. Unpublished M.Sc. Thesis, North Carolina State University, Raleigh, USA.

Anderson, C., T. Sheldon and J. Dubay, 1990. The effects of instruction on college non-majors conceptions of respiration and photosynthesis. J. Res. Sci. Teach., 27 (8): 761-776.

Ayas, A., S. Köse and E. Taş, 2002. The effects of computer-assisted instruction on misconceptions about photosynthesis. The 1st International Education Conference, Changing Times Changing Needs, Eastern Mediterranean University, Gazimagusa-Northern Cyprus.

Barak, J., M. Gorodetsky and B. Gurion, 1999. As process as it can get: Students understanding of biological processes. Int. J. Sci. Educ., 21 (12): 1281-1292.

Boyes, E. and M. Stanisstreet, 1990. Pupils ideas concerning energy sources. Int. J. Sci. Educ., 12 (5): 513-529.

Boyes, E. and M. Stanisstreet, 1991. Misconceptions in first-year undergraduate science students about energy sources for living organisms. J. Biol. Educ., 25 (3): 208-214.

Çepni, S., E. Taş and S. Köse, 2006. The effects of computer-assisted material on students cognitive levels, misconceptions and attitudes towards science. Comput. Educ., 46 (2): 192-205.

Diakidoy, I.A., P. Kendeou and C. Ioannides, 2003. Reading about energy: The effects of text structure in science learning and conceptual change. Contemp. Educ. Psychol., 28 (3): 335-356.

Griffard, P.B. and J.H. Wandersee, 2001. The two-tier instrument on photosynthesis: What does it diagnose? Int. J. Sci. Educ., 23 (10): 1039-1052.

Gürdal, A., F. Şahin and H. Bayram, 1999. Ilköğretim Öğretmen Adaylarının Enerji Konusunda Bütünlüğü Sağlama ve Ilişki Kurma Düzeyleri Üzerine Bir Araştırma. DEÜ Buca Eğitim Fakültesi Dergisi, Özel Sayı, 10: 382-395.

Haslam, F. and D.F. Treagust, 1987. Diagnosing secondary students misconceptions of photosynthesis and respiration in plants using a two-tier multiple choice instrument. J. Biol. Educ., 21 (3): 203-211.

Hill, D.G., 1997. Conceptual Change Through the use of student-generated analogies of photosynthesis and respiration by college non-science majors. Unpublished Ph.D Thesis, Georgia University, Athens, Georgia, USA.

Kao, H.L., 2007. A study of aboriginal and urban junior high school students alternative conceptions on the definition of respiration. Int. J. Sci. Educ., 29 (4): 517-533.

Kayalı, H.A., R.Ö. Ürek, B. Cavaş and L. Tahran, 2000. Ilköğretim Enerji Kavramı ve Enerji Tasarrufuna Yönelik Bir Çalışma. IV. Fen Bilimleri Eğitimi Kongresi, HÜ, Ankara.

Konuk, M. and S. Kılıç, 1998. Fen Bilimleri Öğrencilerinde Bitki ve Hayvanlardaki Enerji Kaynağı Konusunda Kavram Yanılgıları. III. Ulusal Fen Bilimleri Eğitimi Sempozyumu, KTÜ, Trabzon.

Köse, S., 2004. Effectiveness of conceptual change texts accompanied with concept mapping instructions on overcoming prospective science teachers misconceptions of photosynthesis and respiration in plants. Unpublished Ph.D Thesis, KTU, Trabzon, Turkey.

Köse, S. and M. Uşak, 2006. Determination of prospective science teachers misconceptions: photosynthesis and respiration in plants. Int. J. Environ. Sci. Educ., 1 (1): 25-52.

Köse, S., H. Bağ, A. Sürücü and E. Uçak, 2006. The opinions of prospective science teachers about energy sources for living organisms. Int. J. Environ. Sci. Educ., 1(2): 141-152.

Köse, S., 2007. The effects of concept mapping instruction on overcoming 9th grade students misconception about diffusion and osmosis. J. Baltic Sci. Educ., 6 (2): 16-25.

Köse, S., 2008. Diagnosing student misconceptions: Using drawings as a research method. W. Applied Sci. J., 3 (2): 283-293.

Marmaroti, P. and D. Galanopoulou, 2006. Pupils understanding of photosynthesis: A questionnaire for the simultaneous assessment of all aspects. Int. J. Sci. Educ., 28 (4): 383-403.

Mikkilä-Erdmann, M., 2001. Improving conceptual change concerning photosynthesis through text design. Learning and Instruction, 11: 241-257.

Özay, E. and H. Öztaş, 2003. Secondary students interpretations of photosynthesis and plant nutrition. J. Biol. Educ., 37 (2): 68-70.

Özmen, H., F. Dumanoğlu and A. Ayas, 2000. Ortaöğretimde Enerji Kavramının Öğretimi ve Enerji Eğitimi. IV. Fen Bilimleri Eğitimi Kongresi, HÜ, Ankara, Turkey.

Uşak, M., 2005. Prospective elementary science teachers pedagogical content knowledge about flowering plants. Unpublished Ph.D Thesis, Gazi University, Ankara, Turkey.

Yip, D.Y., 1998. Teachers misconceptions of the circulatory system. J. Biol. Educ., 32 (3): 207-216.