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TURKISH PRE-SERVICE TEACHERS' VIEWS OF SCIENCE-TECHNOLOGY-SOCIETY: INFLUENCE OF A HISTORY OF SCIENCE COURSE

Ebru Öztürk-Akar,
Doğan Doğan

Abstract. *This research is conducted to explore the pre-service teachers' views of science-technology-society (STS) issues and to investigate the influence of a History of Science (HOS) course on these views. The influence of teaching STS issues through different instructional approaches on the pre-service teachers' views was also examined. Sample is consisted of 93 pre-service teachers. 11 adapted items of Views of Science-Technology-Society (VOSTS) questionnaire (Aikenhead, Ryan & Fleming, 1989) were administered. Descriptive and inferential statistics (Wilcoxon Sign-Test) were used to examine and compare pre-service teachers' pre- and post-test responses. Findings revealed that the HOS course and the instructional approach did not have significant influences on the pre-service teachers' STS views.*

Key words: *science-technology-society, pre-service teachers, history of science, views of science-technology-society questionnaire.*

Ebru Öztürk-Akar,
Doğan Doğan
Abant İzzet Baysal University, Bolu, Turkey

Introduction

The international science education community has recognized the important role of educating pre-service teachers about the interdependence of Science, Technology, and Society (STS) and thus to promote the development of an informed and responsible citizenry in highly industrialized social life (Yalvaç, Tekkaya, Çakıroğlu & Kahyaoğlu, 2007). STS teaching, students' and teachers' understanding of how science, technology, and society influence one another have become a worldwide focus of research within the last decades. Findings related with pre-service teachers' views about characteristics of scientists, and interactions among science, technology and society, were reported from Canada (Aikenhead, 1987; Ryan, 1987), USA (Bradford, Rubba, & Harkness, 1995), Germany (Schallies, Wellensiek, & Lembens, 2002), United Kingdom (Botton & Brown, 1998), and Brunei (Tairab, 2001). The number of research conducted to investigate adequacy of pre-service teachers' STS views is also increasing in several countries, including Turkey.

Due to its importance, STS has also been integrated into the Turkish teacher education programs. Courses such History of Science and Scientific Research Methods were introduced in all teacher education programs with the assumption that these courses enhance pre-service teachers' views about science-technology and society (STS) relations, and thus help them to become scientifically literate, informed and responsible individuals. They, in turn, promote knowledge of science in the society. Yet, there is

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no empirical research to validate these assumptions and inferences made to train scientifically literate teachers through HOS and/or Scientific Research Methods courses.

Problem of Research

This study was conducted to explore the pre-service teachers' views of science-technology-society (STS) issues and to investigate the influence of a History of Science (HOS) course on these views. The influence of teaching STS issues through different instructional approaches i.e. use of implicit and explicit teaching methodologies on the pre-service teachers' views of STS was also examined. Research questions were:

1. What kind of views of STS do participants hold?
2. What is the influence of HOS course on participants' views of STS?
3. Is there a difference between participants' views of STS when different teaching methodologies were used?

Research Focus

Today, the main goal of science education is to reach scientific and technological literacy for all. Therefore, science teachers are expected to possess consistent views about STS issues with the current literature. This requires teacher education programs to equip pre-service teachers with the necessary skills and knowledge in a learning environment that foster their understanding of the interaction among science, technology and society (Sunar & Geban, 2011; Yager, Tamir & Kellerman, 1994). Handling science issues as a part of societal and environmental questions strongly support pre-service teachers' critical thinking for the future, too (Aikenhead, 1994). Therefore, coursework in the history of science has been suggested by many as a possible way to enhance pre-service teachers' conceptions (Abd-El-Khalick, Bell & Lederman, 1998). Solomon, Duveen, Scot, and McCarthy (1992) documented how learning through history of science might influence pupils' views of the tentative nature of scientific ideas and their relationship to the social and cultural contexts within which they were developed.

Although the above mentioned assumptions and inferences were used as the references to introduce HOS course to train scientifically literate teachers in Turkish teacher education programs, research has indicated that science and technology dichotomy and the various perspectives on the multidimensional nature of science might contribute to the development of alternative views held by pre-service teachers (Aikenhead and Ryan, 1992). The existence of no consensus on nature of science and any agreed definitions of scientific knowledge among philosophers of science, historians, and science educators are also acknowledged (Abd-El-Khalick and Lederman, 2000; Tairab, 2001). Research into the nature of science, scientific knowledge and technology within the last decade in Turkey also reported that large percentages of Turkish pre-service teachers do not possess adequate conceptions about NOS and STS. Aslan, Yalçın and Taşar (2009) reported naive conceptions of 48 Turkish science and technology teachers about definition of science, nature of observations and scientific knowledge, characteristics of hypothesis, theory and law, and scientific method. Yalvaç, Tekkaya, Çakıroğlu and Kahyaoğlu (2007), Sunar and Geban (2011) also pointed to Turkish pre-service science teachers' failure to differentiate hypotheses, laws and theories. Aydın and Taşar (2010) stated how technology is seen as a subdiscipline or output of applied science by Turkish pre-service teachers. Kahyaoğlu (2004) also reported how 176 pre-service science teachers confused the definitions of science and technology, and had very mixed views about the influences of society on science and technology. Characteristics of the textbooks used in teacher education programs, lack of knowledge and common misconceptions were yet identified as the sources of pre-service teachers' inadequate conceptions of science and technology (Aslan, Yalçın & Taşar, 2009).

Under the circumstances, this study intends to provide further insights into pre-service teachers' views of STS and to provide empirical data to discuss the contribution of a HOS course to pre-service teachers' STS views.

Methodology of Research

General Background of Research

HOS Course

HOS is a 2 hours per week- must course in all teacher education programs in Turkey. Content covers 'the development of science since early civilizations`. Developments in astronomy, mathematics, physics, medicine, biology etc. are separately examined. The reasons and consequences of the 20th century science and technology revolutions are also discussed. It is intended that any pre-service teacher taking HOS course would acquire basic knowledge of the scientific developments to see how scientific developments are historically and culturally situated. Although STS was not a separate subject in the HOS course, science, technology and societal interactions are used as a framework for each historical period throughout the course. Scientific issues, societal and technological aspects of phenomena are studied together.

Sample of Research

Participants of the study were 93 pre-service teachers in two teacher education programs who were taking the HOS course in the autumn semester in a state university. HOS course is studied in the spring semester in other teacher education programs at the same university. Sample consists of 28 male and 57 female pre-service teachers. Participants from the first group (n=50) were non-science majors whereas participants from the second group (n=43) were science majors. The majority of the participants (n=75) attended elective and/or compulsory science courses in secondary school.

Table 1. Characteristics of the participants.

	Gender		Attendance to Science Courses	
Group	**Male**	**Female**	**Yes**	**No**
1	12	38	44	6
2	16	19	31	3
Total	28	57	75	9

Instrument and Procedures

Examination of science, technology and societal interactions provided an opportunity to evaluate the influence of using different instructional approaches in the HOS course. Although same textbook was used in both of the groups, a teacher centered instructional approach i.e. lectures and presentations were used in the first group. On the other hand, teaching was student centered in the second group to emphasize the target aspects of STS and to enable participants to think about and reflect on different STS issues i.e. whole class discussions, inquiry based activities, speeches by invited speakers and presentations. Considering the characteristics of the instructional approach and the activities integrated in the groups (Khishfe & Abd-El-Khalick, 2002), it is concluded that the STS issues were implicitly taught in the first group and explicitly taught in the second group.

Different evaluation methods were also utilized in the groups. Short answer mid-term and final examinations were used in the first group whereas participants' performances were evaluated through research assignments, participation in group works and individual and group presentations in the second group.

In order to explore pre-service teachers' views of STS, 11 items of Views of Science-Technology-Society (VOSTS) questionnaire (Aikenhead, Ryan & Fleming, 1989) were adapted and administered.

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The adapted questionnaire is consisted of five subscales i.e. defining science, influence of society on science/technology, influence of science/technology on society, characteristics of scientists, and social construction of scientific knowledge (see Table 2 for all items). The reason for using these items is their representativeness of the VOSTS and appropriateness to test participants' STS views. The items were also suitable to be used in the Turkish culture. The translation-back-translation of the original items, and meaning check was done by the researchers themselves. It is assumed that the VOSTS items possessed an inherent validity that originated from the process used to develop them (Aikenhead & Ryan, 1992).

Table 2. Items used to explore participants' STS views.

ITEM
Defining Science
Item1: Defining science is difficult because science is complex and does many things. But MAINLY science is:
Influence of Society on Science/Technology
Item 2: Some cultures have a particular viewpoint on nature and man. Scientists and scientific research are affected by the religious or ethical views of the culture where the work is done.
Item 3: Some communities produce more scientists than other communities. This happens as a result of the upbringing which children receive from their family, schools and community.
Influence of Science/Technology on Society
Item 4: Most Turkish scientists are concerned with the potential effects (both helpful and harmful) that might result from their discoveries.
Item 5: Scientists and engineers should be the ones to decide on future biotechnology in Turkey (for example, recombinant DNA, gene splicing, developing ore-digging bacteria or snow-making bacteria, etc.) because scientists and engineers are the people who know the facts best. Scientists and engineers should decide:
Item 6: Scientists can solve any practical everyday problem best (for example, getting a car out of a ditch, cooking, or caring for a pet) because scientists know more science.
Characteristics of Scientists
Item 7: The best scientists are always very open-minded, logical, unbiased and objective in their work. These personal characteristics are needed for doing the best science. The best scientists display these characteristics.
Item 8: Scientists have practically no family life or social life because they need to be so deeply involved in their work.
Item 9: There are many more women scientists today than there used to be. This will make a difference to the scientific discoveries which are made. Scientific discoveries made by women will tend to be different than those made by men.
Social Construction of Scientific Knowledge
Item 10: Scientists compete for research funds and for the priority in a discovery Sometimes fierce competition causes scientists to act in secrecy, lift ideas from other scientists, and lobby for money. In other words, sometimes scientists break the rules of science (rules such as sharing results, honesty, independence, etc.).
Item 11: A scientist may play tennis, go to parties, or attend conferences with other people. Because these social contacts can influence the content of the scientific knowledge and his/her work.

As in the original VOSTS, participants were provided with a statement followed by different positions expressing different viewpoints on a wide range of topics related to science-technology-society (See Table 2). As seen in Table 2, the participants were asked to select only one position that is closest to their personal viewpoint or belief. A three category numerical scheme developed by Rubba et al. (1996) was used to categorize participants' responses under three categories as "3=realistic""2=has merit" and "1=naive". Responses in the category of "Realistic" mean that pre-service teachers have appropriate/ contemporary views of STS relations. Responses in the category of "Has merit" mean that pre-service teachers have reasonable views i.e. valid but not realistic points of view about STS relations. Responses in the category of "Naive" mean that pre-service teachers have inappropriate or not legitimate views of STS relations.

In order to determine changes in the participants' views of STS, the questionnaire was administered twice i.e. in the first and last weeks of 2011 - 2012 fall term.

Data Analysis

In order to explore and compare pre-service teachers' views of STS, descriptive and inferential statistics were used. Frequencies of the responses were calculated for each item. A nonparametric Wilcoxon-Sign test was used to compare participants' views of STS at the beginning and end of the HOS course. On the basis of previous research that reported explicit teaching to be more effective than implicit teaching (Akerson *et al*., 2000; Khishfe & Abd-El-Khalick, 2002; Lederman & Lederman, 2004), it was hypothesized that explicit teaching of STS relations in the second group contributes more to participants' STS views i.e. participants in the second group would have more realistic views of STS in the post-test.

Hypotheses:

Ho: There is no difference between item response categories from pre-test to post-test within the second group.

H1: There is a positive difference between item response categories from pre-test to post-test within the second group where STS issues were explicitly taught.

Results of Research

Defining Science

In order to address participants' views about the definition of science the following item was used: "Defining science is difficult because science is complex and does many things." As seen in Table 3, participants in both of the groups had merited views about the definition of science. There were statistically no significant differences between their pre- and post-test responses. In the first group 60.4% of pre-test responses and 64.6% of post-test responses were categorized as "has merit". In the second group, 83.9% of pre-test responses and 63.6% of post-test responses were categorized as "has merit".

Table 3. Pre- and post-test results of groups.

		Pretest			Posttest		
Item No.	Group	N(%)	HM (%)	R (%)	N (%)	HM (%)	R (%)
1. Defining science	1	10.4	60.4	29.2	12.5	64.6	22.9
	2	12.9	83.9	3.2	33.3	63.6	3.0
2. Influence of Society on Science/Technology	1	35.4	20.8	43.8	21.7	23.9	54.3
	2	29.0	19.4	51.6	27.3	42.4	30.3
3 Influence of Society on Science/Technology	1	0	30.6	69.4	4.1	28.6	67.3
	2	73.5	14.7	11.8	64.7	26.5	8.8
4. Influence of Science/Technology on Society	1	22.0	46.0	32.0	16.3	36.7	46.9
	2	30.3	27.3	42.4	33.3	48.5	18.2
5. Influence of Science/Technology on Society	1	8.0	16.0	76.0	10.0	36.0	54.0
	2	41.2	29.4	29.4	41.9	29.0	29.0
6. Influence of Science/Technology on Society	1	23.3	41.9	34.9	13.6	45.5	40.9
	2	36.7	23.3	40.0	76.7	13.3	10.0

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		Pretest			Posttest		
Item No.	Group	N(%)	HM (%)	R (%)	N (%)	HM (%)	R (%)
7 Characteristics of Scientists	1	14.6	6.3	79.2	22.4	6.1	71.4
	2	82.4	2.9	14.7	70.6	2.9	26.5
8 Characteristics of Scientists	1	12.0	4.0	84.0	10.0	6.0	84.0
	2	72.7	15.2	12.1	70.6	17.6	11.8
9 Characteristics of Scientists	1	20.4	36.7	42.9	35.4	37.5	27.1
	2	37.5	21.9	40.6	27.3	24.2	48.5
10 Social Construction of Scientific Knowledge	1	31.3	62.5	6.3	28.3	67.4	4.3
	2	6.2	53.1	40.6	6.1	51.5	42.4
11 Social Construction of Scientific Knowledge	1	12.2	59.2	28.6	12.0	38.0	50.0
	2	24.2	60.6	15.2	50.0	31.2	18.8

Influence of Society on Science/Technology

Two items were used to examine pre-service teachers' views about the influence of society on science and technology. The first item addressed participants' views about the influence of the religious and/or ethical views of the culture on scientists and scientific research (see Table 2). The second item addressed the impact of upbringing that some communities produce more scientists than other communities.

As seen in Table 3, first group had realistic views about the influence of society on science and technology. 43.8% of their pre-test responses and 54.3% of their post-test responses were categorized as "realistic". Second group had "merited" and "realistic" views about the same item. 51.6% of their pre-test responses were categorized as "realistic" and 42.4% of their post-test responses were categorized as "has merit". For both of the groups, there were statistically no significant differences between their pre- and post-test responses.

About the impact of upbringing that some communities produce more scientists than other communities, pre-service teachers in the first group had realistic views i.e. 69.4% of their pre-test responses and 67.3% of their post -test responses were categorized as "realistic". Yet, pre-service teachers in the second group had "naïve" views about the same item at the beginning and at the end of the HOS course. As seen in Table 3, 73.5% of their pre-test responses and 64.7% of their post-test responses were categorized as "naïve". For both of the groups, there were no statistically significant differences between their pre- and post-test responses.

Influence of Science/Technology on Society

There were three items under the Influence of Society on Science and Technology subscale. The first item was used to address participants' views about the social responsibilities of Turkish scientists. The second item addressed who should decide on future applications of biotechnology in Turkey. The last item asked participants' views about the statement of "Scientists can solve any practical everyday problem best because scientists know more science".

As seen in Table3, pre-service teachers in both of the groups had "realistic" and "merited" views about the social responsibilities of Turkish scientists at the beginning and at the end of the HOS course. 46.0% of the first group's pre-test responses were categorized as "has merit" and 46.9% of their post-test responses were categorized as "realistic". In the second group, 42.4% of the pre-test responses were categorized as "realistic" and 48.5% of the post-test responses were categorized as "has merit". For both of the groups, there was no statistically significant difference between their pre- and post-test responses.

Pre-service teachers' views about who should decide on future applications of biotechnology in Turkey were "realistic" in the first group. As seen in Table 3, 76.0% of their pre-test responses and 54.0% of their post-test responses were categorized as realistic. Yet, pre-service teachers in the second group had "naïve" views about the same item. 41.2% and 41.9% of their responses were categorized as "naïve" in the pre- and post-test respectively. Similar to the first group, there was no statistically significant difference between their pre- and post test responses about who should decide on future applications of biotechnology in Turkey.

About the last item of influence of science/technology on society, pre-service teachers in the first group had "merited" views. There was no statistically significant difference between their pre- and post-test responses. 41.9% of their pre-test responses and 45.5% of their post-test responses were categorized as "has merit". However, views of pre-service teachers about the same item changed from "realistic" to "naïve" in the second group. Although, majority of the pre-service teachers' responses were categorized as "has merit" and "realistic" in the pre-test (23.3% and 40.0% respectively), 76.7% of the responses were categorized as "naive" in the post test (p=.001, see Table 4). Since it was hypothesized that there is no difference between item response categories from pre-test to post-test within the second group, the null hypothesis (Ho) was rejected. The expected positive difference between the pre- and post-test responses within the second group was not observed either. In contrast, it was seen that pre-service teachers' "merited" and "realistic" views at the beginning of the HOS course transformed into "naïve" views at the end of the course.

Table 4. Change in the second group's views about Item 6.

Item No.		Pretest-Postest	N	Mean Rank	Sum of Ranks	Z	p
		Negative Ranks	13	9,69	126,00		
6 Influence of Science/Technology on Society	Gr2	Positive Ranks	1	5,00	5,00	-3,226	0.001
		Ties	14				

Characteristics of Scientists

There were three items to explore participants' views about the characteristics of scientists (See Table 2). The first item addressed the personal characteristics of scientists. The second item addressed the presence of scientists' social and family lives. The last item addressed the number of women scientists and characteristics of the scientific discoveries made by them.

About the personal characteristics of scientists, pre-service teachers in the first group had "realistic" views at the beginning and at the end of the HOS course. As seen in Table 3, 79.2% of their pre-test responses and 71.4% of their post-test responses were categorized as "realistic". On the other hand, pre-service teachers in the second group had "naïve" views about the characteristics of scientists. There was no statistically significant difference between their pre- and post-test responses. 82.4% of the pre-test responses and 70.6% of their post-test responses were categorized as "naïve". About the presence of scientists' social and family lives, pre-service teachers in the first group had "realistic" views and pre-service teachers in the second group had "naïve" views. 84.0% of the first group's pre-test responses and 84.0% of their post-test responses were categorized as realistic. 72.7% of the second group's pre-test responses and 70.6% of their post-test responses were categorized as "naïve". There were no statistically significant differences between both groups' pre- and post-test responses. About the number of women scientists and characteristics of the scientific discoveries made by them, pre-service teachers in both groups had "merited" and "realistic" views throughout the HOS course. 42.9% of the first group's pre-

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test responses were categorized as "realistic" and 37.5% of their post-test responses were categorized as "has merit". 40.6% of the second group's pre-test responses and 48.5% of their post-test responses were categorized as "realistic". There were statistically no significant differences between both groups' pre- and post-test responses.

Social Construction of Scientific Knowledge

In order to determine if social contacts have an impact on the discoveries made by the scientists and if scientists break the rules of science when competing for research funds, two items were utilized. Results showed that pre-service teachers in both of the groups had "merited" views about the impact of social contacts on the discoveries made by the scientists. There were no statistically significant differences between both groups' pre- and post-test responses. 62.5% of the first group's pre-test responses and 67.4% of their post-test responses were categorized as "has merit". Similarly, 53.1% of the first group's pre-test responses and 51.5% of their post-test responses were categorized as "has merit".

Pre-service teachers in the first group had "merited" and "realistic" views about the question whether scientists break the rules of science when competing for research funds. As seen in Table 3, 59.2% of their pre-test responses were categorized as "has merit" and 50.0% of their post-test responses were categorized as "realistic". Pre-service teachers in the second group also had "merited" views about the same item at the beginning of the HOS course, i.e. 60.6% of their pre-test responses were categorized as "has merit". Although 50.0% of their post-test responses were categorized as "naïve" at the end of the HOS course, there was no statistically significant difference between their pre- and post-test responses.

Discussion

For six of the items pre-service teachers in both of the groups had "merited" and "realistic" views i.e. the definition of science, the impact of competition and social contacts on the discoveries made by the scientists, the influence of the religious or ethical views of the culture on scientists and scientific research, social responsibilities of Turkish scientists and the number of women scientists and characteristics of the scientific discoveries made by them. For the remaining item response categories, differences were observed between groups. While views of pre-service teachers in the first group were identified as merited and realistic for these items throughout the course, responses of pre-service teachers in the second group remained naïve. Although Zoller and Ben-Chaim (1994) reported differences between the STS profiles of science and non-science majors, such a result was surprising as the second group consisted of science majors. Pre-service teachers in this group were expected to have more realistic views about STS issues both at the beginning and at the end of the course. However, it was observed in this study that studying more science and technology courses does not mean having more accurate conceptions of STS as İrez (2006) and Tekkaya, Çakıroğlu and Özkan (2007) mentioned. This finding also revealed that taking more science courses was unlikely to enhance pre-service teachers' weak understandings of STS relations (Abd-El-Khalick & BouJaoude, 1997). Supporting previous research (Moss, Abrams & Robb, 2001; Shiang & Lederman, 2002), there was also no significant changes of their conceptions before and after HOS course despite the difference in the way STS issues were taught.

Since STS issues were explicitly taught in the second group, pre-service teachers in this group were expected to move to more informed views about the items for which their views were identified as naïve at the beginning of the course. Yet, it appeared that they have moved to less informed views at the end of the course for the item "Scientists can solve any practical everyday problem best because scientists know more science" i.e. they had merited and realistic views about this item at the beginning of the course whereas they ended with naïve views when they finished the course. It is inferred that instead of meaningful learning throughout the course, pre-service teachers rote learned and/or absorbed a static body of knowledge from the textbook (İrez, 2006).

Although Khishfe and Abd-El-Khalick (2002), Lederman and Lederman (2004) reported an explicit and reflective inquiry-oriented approach to be more effective than an implicit inquiry-oriented approach in promoting scientific conceptions, the explicit approach itself did not suffice to improve pre-service teachers' views of STS in the second group, either (Abd-el-Khalick & Lederman, 2000). Due to pre-service teachers' prior inaccurate conceptions of STS, it was not possible to observe the influence of instructional approach on their related views in this study. It was also observed that the pre-service teachers in the first group, where STS issues were implicitly taught, were more informed about STS issues throughout the course. It can be is deduced that pre-service teachers' prior conceptions contributed more to their views of STS issues during the HOS course. Supporting Doğan (2011)'s conclusions, such a result also caused to think that studying social science courses could efficiently contribute to pre-service teachers' views of STS issues too.

Conclusions

The results of this study revealed that studying more science courses does not help pre-service teachers to develop more accurate views of STS. Moreover, the prior beliefs, conceptions and learning experiences could be more influential than a course and/or the instructional approach used to improve pre-service teachers' related conceptions and to facilitate their meaningful learning. As it was observed in this study, pre-service teachers' previous science learning experiences might have already shaped their understanding of science and technology, and they might refer to these experiences during the HOS course. From teacher education perspective, this finding supports Wideen et al. (1998) conclusion that "…beginning teachers are little influenced by the interventions that occur in pre-service teacher education".

Although HOS course was seen as a rich context to enhance pre-service teachers' scientific conceptions, it failed to challenge and change pre-service teachers' inadequate/inaccurate beliefs and to influence their conceptions of STS favorably in this study. In order to promote pre-service teachers' interest and to foster their curiosity to understand and comprehend the impact of science and technology on the society, it is suggested that HOS course should provide pre-service teachers with opportunities to reflect on their beliefs and conceptions of STS issues. STS ideas should also be presented at varying levels of depth and complexity depending on pre-service teachers' background. Instructional approach and course content should be selected and organized accordingly.

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Ebru Öztürk Akar	PhD, Assistant Professor, Abant İzzet Baysal University, Department of Secondary School Science and Mathematics Education, 14280 Gölköy, Bolu, Turkey. E-mail: akar_e@ibu.edu.tr
Doğan Doğan	PhD, Assistant Professor, Abant İzzet Baysal University, Department of Secondary School Science and Mathematics Education, 14280 Gölköy Bolu, Turkey. E-mail: ddogan@ibu.edu.tr