

Effect of Triadic Teaching Approach in Some Environmental Subjects: Prospective Science Teachers Practice

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•Received 03 January 2015 •Revised 29 February 2016 •Accepted 24 March 2016

Effective use of educational technologies by teachers in classrooms has come into prominence as the integration of technology into educational settings in today's world is considered as an inseparable part of an effective teaching. Besides, recent teacher training curriculums too emphasize the use of teaching strategies including technology to enhance student achievements. For this reason, it is decided to design a research focusing on to the use of an educational technologies based triadic teaching approach in teaching some environment-related subjects (global warming, ozone layer, air pollution, acid rains) of the science curriculum with 30 prospective science teachers through the special teaching methods course. The triadic teaching approach is comprised of internet-web based online research, poster preparation process activities and mini symposium activities steps. In order to establish the effect of the triadic teaching approach in selected environment-related subjects to meaningful learning of students, a pre and post word association test has applied, concept network maps of prospective teachers were drawn performed with them to collect their opinions on the triadic teaching approach. Findings of the study revealed that the triadic teaching approach has contributed to meaningful learning and ability of utilizing educational technologies of prospective teachers.

Keywords: teacher education, environmental education, triadic teaching approach, poster process, teaching practice

INTRODUCTION

In the context of environmental issues and overcoming them, role of humans is getting more important and ways of educating people effectively in helping these issues sorted is in the scope of researchers. Students (as well as teachers) conceptions of global environmental issues, such as global warming, ozone depletion, air pollution and acid rains have been a focus of empirical research for

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doi: 10.12973/ijese.2016.323a

more than a decade (Francis *et al*, 1993; Plunkett and Rye *et al*, 1994; Boyes and Stanisstreet, 1994; 1997; Skamp, 1994; Christidou and Koulaidis, 1996; Koulaidis and Christidou, 1999). This might be attributed to the fact that research in other, related fields (science education in particular) had already indicated that children (as well as non-specialist adults) conceptualise scientific concepts and phenomena in alternative, idiosyncratic ways (Driver *et al*, 1994). This insight, together with the popularity and topicality of contemporary environmental issues turned researchers attention towards the ways students understand and conceptualise them. Moreover, the general public (including students) as well as educational institutions have exhibited an increasing interest and concern for these issues, mainly reflected in their increasing coverage in the mass media in the first case, and in the urge for necessary and appropriate changes in the curricula in the second. The nature of environmental education requires everyday practices, learning by doing and real life experiences. Accordingly, learning practices allowing students to take responsibility, conduct research and use creativity are more effective and favorable. Latest science curriculum too aims the effective use of technological means in education and emphasizes the advantages of new teaching approaches (drama, role playing, poster, authentic learning, computer-assisted learning etc.) in science courses (Dunstan and Bassinger, 1997; Riffell & Sibley, 2005; Kaya *et al*, 2009; Hubenthal *et al*, 2011). Our research is thus designed upon the aim of teaching prospective science teachers effective utilization of technology in science classes with the triadic teaching approach. The purpose of this study is to explore the effect of the triadic teaching approach on the meaningful learning of selected environmental subjects (global warming, ozone layer, air pollution, acid rains) of prospective teachers. Moreover, it is aimed to upskill prospective science teachers with the ability of using the triadic teaching approach and technological means in science subjects in their future career.

Triadic teaching approach is comprised of three main activities; internet-web based online research, poster preparation and a mini-symposium (Kaya *et al*. 2009). By internet-web based online research step, prospective teachers were aimed to analyze various sources of information and create their own schemas of the content. With the poster preparation step, prospective teachers were aimed to take the responsibility of their learning, use the technological means in education effectively and improve their creativity and skills. In the literature, poster preparation is found to improve research and analyzing skills and increase motivation and success (Moule *et al*. 1998; Riffell & Sibley, 2005); increase meaningful and permanent learning (Dunstan and Bassinger, 1997; Hubenthal *et al*, 2011; Yalvaç and Doğan, 2011) improve creativity, cooperative learning, critical thinking, research abilities and communication skills of students (Baird, 1991). With mini-symposium, which is the last step of the triadic teaching, it is aimed to create a setting for the prospective teachers in which they could experience a scientists routine.

Starting from given features, triadic teaching approach contains the benefits of poster activities. In this context, the triadic teaching approach is a method supporting meaningful and lasting learning, creativity, research and questioning skills, and the development of scientific research steps.

In the literature, triadic teaching approach has been used by Doğan who is one of the authors of the study called Changes in Attitudes towards Science-Technology-Society of Pre-service Science Teachers. In the study, the use of the triadic teaching approach in the science, technology and society courses with teacher candidates of science has the positive effects on students attitudes towards science and technology and society issues and the activities such as internet-based research, preparing posters, mini-symposium which are the steps of the triadic teaching approach were introduced in the literature. There is no another study concerning this approach in the literature apart from study of Kaya, Yager and Dogan (2009).

Moreover, when the studies about the poster activities in the literature were examined, the study about the impact of the poster activities on students meaningful and lasting learning wasnt observed. The studies are more related to the importance, the preparation steps and preparing the rules of the poster activities. For this reason, our study is a first in the literature in terms of adapting triadic teaching approach to environmental education. It is believed that it will contribute to study to be held in the future.

METHOD

Research design

This research is a single-group experimental research with pre and posttests (Campbell and Stanley, 1963). At the beginning of the special teaching methods course, prospective teachers were given a word association pre-test on the environment subjects and their concept network maps were drawn prior to the application of the process to set their already existing knowledge and opinions on the subjects and at the end of the semester, they were given a word association test as a post-test and their concept network maps were re-drawn to determine the effect the triadic teaching process to their mental schemata on the subjects. At the end of the process, prospective teachers were interviewed about their opinions on the triadic teaching approach.

Study group

The research is carried out with 30 prospective science teachers currently studying in the faculty of education (20 females, 10 male), aged 21-22 and randomly chosen among the 120 prospective teachers in the faculty of education of Gaziosmanpaşa University.

Data collection tools and the process

The study is carried out with prospective science teachers currently studying in the faculty of education and the experimental process, namely the triadic teaching approach is conducted through the special teaching methods course. Activities performed during the special teaching methods course in the scope of this study are given on the Table 1.

Table 1. Outlines of the special teaching methods course: Research, Procedure and Design.

Pre-test data collection	Special teaching methods Course (3 weeks)	Organizing The Triadic Teaching Approach (2 Week)	Triadic Teaching Approach activities (8 weeks)	Post-test data collection
Word Association Pre-test and drawing concept network maps prior to the implementation	Orientation of special teaching methods course to students	Formation of groups, preparation for the triadic teaching procedure	• Internet-web based online research • Poster activities - Poster preparation process • Mini-symposium activities	Word Association Post-test and drawing concept network maps after the implementation and interviews with students

Pre-test data collection

Word association test was applied and concept network maps of prospective teachers were drawn prior to the implementation process in order to determine prior knowledge of the students on the selected environmental subjects. The purpose of this prior assessment is to determine the prior knowledge and misconceptions of prospective teachers and compare with the post-implementation data. With the use of word association test, conceptual structures of students in associating between these structures can be set. Word association tests are utilized to establish if meaningful learning occurred as a result of a certain implementation (Shavelson, 1974; Tao and Gunstone, 1999; Jonassen, Reeves Kong & Peters, 1997; Bahar et al., 1999; Atasoy, 2002; Bahar et al, 2006; Özatlı, 2006; Yalvac 2008; Kostova and Radoynovsk in 2010; Postman and Keppel, 2014). During the implementation of the word association test, each one of the selected environmental subjects were written on a paper and students were asked to write down first concepts those words reminded them of in 30 seconds. Selected key concepts given to students were global warming, ozone layer, air pollution and acid rains.

Special teaching methods course (3 weeks)

During the introductory 3 weeks, the students were asked to read about teaching approaches and some important environmental issues from various news services that could be used to plan their activities that would characterize special teaching methods course.

Students located research reports where social issues were used as starting points for study and research as reported in other research (Bybee 1987; Hunt 1988; Kumar 1994; Yager 1993; transfer Kaya, 2009). The main purpose of these 3 weeks was to encourage the students to learn about important current issues that would be interesting and important to pursue. Students were encouraged to examine news reports, especially related to environment .

During these introductory weeks, the students discussed their efforts with each other in small-groups rarely reporting on their work as a part of whole-class discussions. The students were organized in small-groups of five before they were involved with interactions with other students and/or experts located from the internet. The second goal of the new course was to enable the students to deal with the concept of environmental problem as well as multidimensional as needed for their work in dealing with current social problems

Organizing the triadic teaching approach (2 week)

There were various activities carried out for the following 2 weeks in order to familiarize the students concerning the three staged approach and to help them carry out internet-web based online searches for information, how to compile and present the results in a mini symposium, and how they could exhibit their findings as poster presentations. All student groups then prepared to do their own research. Internet-web based online searches the students were given practical information on how to carry out a online search. The students also designed and performed their own investigations to support their research—sometimes recommended by experts with whom they had been in contact.

Triadic teaching approach activities (8 weeks).

Triadic teaching approach is consisted of: internet-web based online research, poster preparation process activities, poster preparation and mini-symposium. Procedures during these activities are given below:

i. Internet-web based online searches

The students were given practical information on how to carry out a online search. They were shown how to utilize internet data bases provided by the university and the use of internet search engines. This phase involved the use of internet and online library data as well as traditional print resources.

ii. Poster preparation process and the activities

Second phase of the triadic teaching process is poster preparation activities. Poster activities is a teaching method designed with remarkable visuals, outlined texts (Seidman, 2008), messages blended with creativity and brave colors (Hegarty, 1998), and enabling the link between the visuality and the subject (Hubenthal et al. 2011). During this step, prospective teachers were explained the rules of poster preparation. Preparing the posters, the formats identified by the researchers in the literature (Hammarling & Higham, 1996; Huddle, 2000; Hollander, 2002) were used and showing the posters examples (NASA, 2010) the embodiment of the activity was provided. After taking expert opinions the topics related to some identified environmental issues were distributed to students, it was guided them in the poster-making process.

The selected environmental subjects in the first three weeks of the special teaching methods course were processed in the following 8 weeks of the course with certain activities. During the process, prospective teachers were formed groups of 5 students. Each week during the course, groups were required to carry out necessary assignments for the mini-symposium and prepared their posters individually.

iii. Mini-Symposium Activities

Having completed their research, the student groups presented their findings to their friends and instructors in the form of mini symposia which they designed in ways described to them by professionals. Prior to initiating the first mini symposium, a program schedule containing the dates and topics for the mini symposia and the names of the students involved with each were distributed to whole faculty via e-mails and written announcements. Almost all of the students presented their findings with the assistance of power point and data displays. Each mini symposium took approximately an hour. Following each mini-symposium, the students and the other participating teacher candidates and instructors discussed their views of each presentation. Afterwards, the audience proceeded to ask questions as well.

Post-test data collection

At the end of the implementation process, prospective teachers were re-given the word association test and their concept network maps were re-drawn to assess the learning outcomes of the process. In addition, interviews performed with prospective teachers to evaluate their opinions on the triadic teaching approach and to better assess the implementation. These interviews enabled to conclude on the

effectiveness of the implementation and their opinions on the triadic teaching approach.

Questions forwarded to prospective teachers during the interviews;

- Did the internet-web based online research help you understand the related subject better?
- What did the poster preparation process bring you?
- What did the mini-symposium bring you?
- Did the triadic teaching approach contribute to your effective use of technology?

Data analysis

In the analyses of the quantitative data, obtained from the pre and post word association tests, a similar approach is followed like Bahar and Ozatlıs (2010) and concepts in the literature were reviewed and compared with the ones obtained from the prospective teachers. In assessment of the data, each answer related with the key concepts, in direct relation with the subject, scientific and accurate were graded 1 point and recorded into the SPSS software to perform t-test.

After the word association test, answers of the prospective teachers to each key concept are determined. Answers were assigned to the related key concepts and frequency tables were prepared to find out how many times a certain key concept is repeated. For each key concept arose in the frequency table, a comparison is made by determining the number of varieties of words. By using the data in the frequency tables, concept network maps representing cognitive structures of the prospective teachers on the subject were drawn. In addition, interviews were performed to find out the effectiveness of the triadic teaching approach. In the interview, 4 open-ended questions were asked and the answers were analyzed. In the data analysis, quality and relation of the concepts in the concept network map were examined and answers to the interview questions were represented as frequencies (f) and percentages (%) and sample answers of the prospective teachers were added. Thus the assessment of the process became more efficient by concept network maps and interview findings.

FINDINGS

Comparison of the pre and post frequency tables

Percentages of the answered word varieties found on the pre-post frequency tables and the increase in the word association test is given on the Table 2. Examination of the Table 2 reveals that the number of answered words to the post-test is more than the number of answered words to the pre-test. However, interpretations solely on the numbers of the answers of prospective teachers to the word association test will fail to leads to make right conclusions. As specified, number of answered words alone can not explain the learning and the quality of them also should be assessed to make right conclusions and this is also true in the sample studies of the related literature (Shavelson, 1974; Bahar, Johnstone and Sutcliffe, 1999; Bahar and Hansell, 2000; Bahar, 2003; Yalvaç, 2008; Yalvaç and Doğan, 2011). Therefore, the quality of the answered words to the key concepts in the word association test should be examined to judge the effectiveness of the implementation.

Table 2. Percentages of the answered word varieties found on the pre-post frequency tables and the increase in the word association test.

Key concepts	Pre-test	Post-test	Increase (%)
Global warming	89	162	54%
Ozone layer	98	125	78%
Air pollution	110	178	61%
Acid rains	96	142	67%
Total number of Variety of Answered Words	393	607	64%

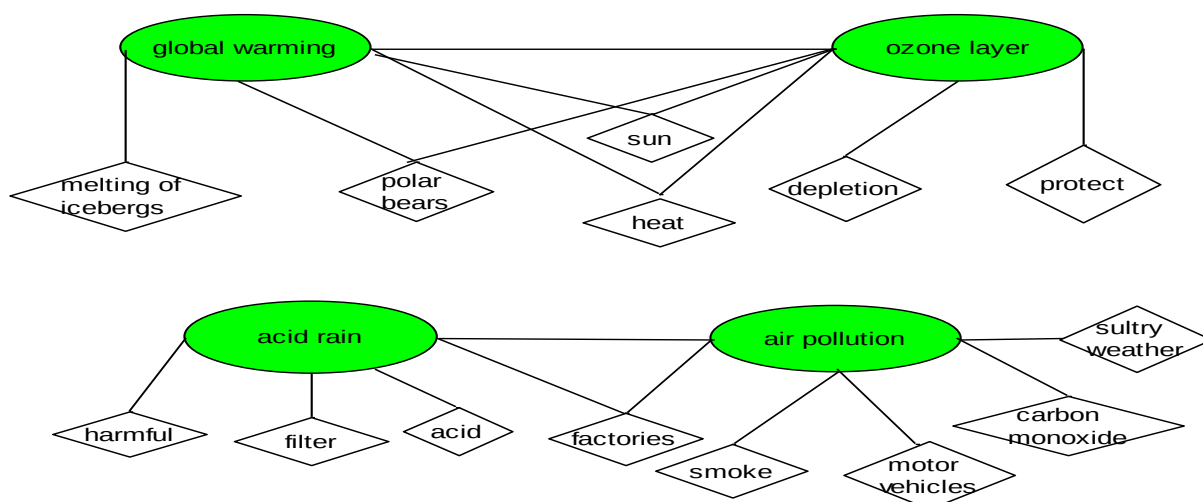
Examining the quality of the answered words to the word association test;

For example, prospective teachers replied to the concept of *ozone layer* in the pre-test with the words; sun (f: 16), heat (f: 16), depletion (f: 15), preserving (f: 15), global warming (f: 14), melting of icebergs (f: 10). In the post-test, different from the pre-test, ultraviolet transmittance (f: 22), chlorofluorocarbons (f: 20), ozone (f: 15), skin cancer (f: 13), visual impairments (f: 12), immunity (f: 12) and halogens (f: 10) were among the emerging words answered. These answers revealed that although prospective teachers had some previous knowledge about the ozone layer, they did not know about the reasoning chemical substances and resulting effects of the ozone layer depletion. The situation has changed after the implementation and many new concepts have produced.

As a result, comparing the quality of the answered words to the pre-test and the post-test, it is revealed that post-test answers are more subject-related, meaningful and superior in associating the key concepts. This situation is a proof of the triadic teaching approach contributing to meaningful learning.

Comparison between pre-test and post-test concept network maps

By using word association tests, concept network maps of students can be drawn (Shavelson, 1974; Bahar, Johnstone and Sutcliffe, 1999; Bahar, 1999; Yalvac, 2008; Ercan, et al., 2010; Yalvaç and Doğan, 2011). In preparation of concept network maps, a frequency table is formed by using answered words of students. By using the data in the frequency table, concept network maps can be drawn. By doing so, cognitive structures and the connections between the concepts, in other words the information network of this structure can be displayed.

**Figure 1.** Pre-test concept network map

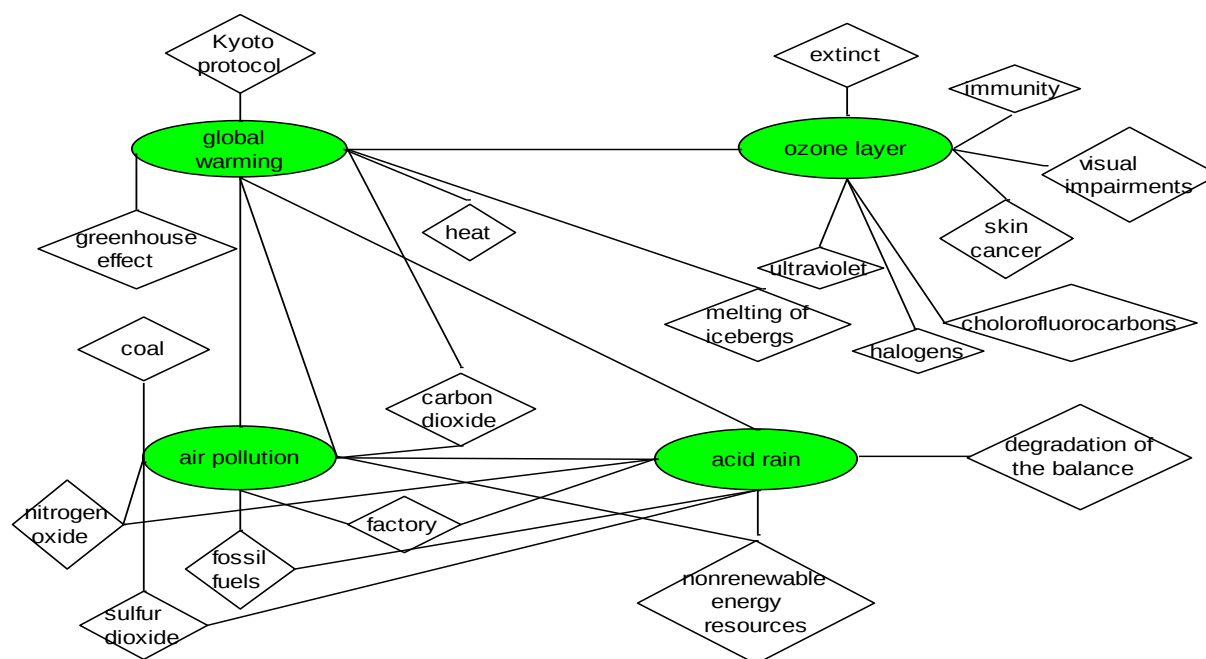


Figure 2. Post-test concept network map

Examination of the pre-test and post-test concept network maps on Figure 1 and Figure 2 revealed that the quality of key concepts formed by the prospective teachers is increased by means of the triadic teaching approach. The increase in the quality of the answers is related with the concepts being directly associated, interrelated and meaningful both between each other and with the subject. Besides it is determined that the disconnectedness between the existing concept networks of prospective teachers is disappeared and many concepts are interrelated with each other. These interpretations are in accordance with findings of many researchers (Shavelson, 1974; Bahar, Johnstone and Sutcliffe, 1999; Bahar and Özatlı, 2003; Yalvaç, 2008; Uzun, et al., 2010; Ercan, et al., 2010; Yalvaç and Doğan, 2011) who stated that concept network maps perceptibly reveal cognitive structures of students.

Likewise, t-test analyses, which are performed to obtain more tangible data on the effectiveness of the implementation, are given on the Table 3 below.

Viewing the data given on Table 3, pre-test mean score of prospective teachers is seen to be $\bar{X} = 15,7$, whereas the post-test scores mean is $\bar{X} = 29,3$. For the triadic teaching approach, a meaningful differentiation ($t = -10,8$, $p < 0.05$) is determined between the pre-test and post-test varieties of answered words. By this result supported by the concept network maps, it is concluded that the triadic teaching approach has contributed to meaningful learning of some environmental subjects and helped to improve cognitive constructs of the prospective teachers.

Findings obtained from interviews

In order to receive opinions of prospective teachers on the triadic teaching approach implemented during the special teaching methods course, an interview is performed with 4 open-ended questions. Questions asked and some answers are given below.

Table 3. T-test results of pre and post test scores of prospective teachers

Test	N	$\bar{X}$	Ss	Sd	t	P
Pre-test	30	15,7	3,96	29	-10,8	.000
Post-test	30	29,3	5,33			

$p < .05$

Interviewer: Did the internet-web based online research help you understand the related subject better?

Student 1: While doing the research, I have learned the subject quite good; I collected all the related researches and classified them. By doing so I have learned to design the information I gathered. I have learned how to perform a research in the future owing to the triadic approach.

Student 2: It teaches both doing a research and learning together. I learned to use technology effectively. I can build up my own information. I learned to get through to scientific sources of information.

Interviewer: What did the poster preparation process bring you?

Student 1: I have never prepared a poster before. I learned to prepare a poster, my knowledge is increased, I worked hard since the assignment is done and I believe I have ended up with a great product. Besides, while preparing the poster, I have learned the functions of PowerPoint software better, like text boxes, colors, and use of figures.

Student 2: During this process, activities and assignments were so meaningful. I felt like working for an organization, I now know what knowledge is for and I learned this by preparing a poster.

Interviewer: What did the mini-symposium bring you?

Student 1: In the future when I become a teacher I want to do such activities with my students. I felt like a scientist. If I learned better this way, so will my students. It is good to know that.

Student 2: When the dates set down for the mini-symposium, I can not tell how excited I was, I felt like an academician. Thus I prepared well and I learned well.

Interviewer: Did the triadic teaching approach contribute to your effective use of technology?

Student 1: Through the triadic learning, I learned doing an online research in the library, I reviewed the literature, learned how to view a scientific publication.

Student 2: While doing online research during the triadic approach process, I learned to search through databases. I now know how I can reach articles and e-books online. I feel more confident in using educational technologies. I learned doing online literature review during the process. I think it was very productive. I feel more equipped technology-wise as a teacher.

Examination of the answers revealed that many skills that prospective teachers should possess were acquired and improved by the implementation of the triadic teaching approach. Prospective teachers stated that they improved their research skills and learned to organize knowledge, improved their oral presentation skills, had knowledge about the subject, acquired meaningful learning, got excited of yielding purposive products, became more equipped in using computers for educative purposes and that they wish to use such activities in the future when they become teachers themselves.

CONCLUSIONS

Our study is aimed to teach concepts of global warming, ozone layer, air pollution and acid rains which are important subjects of science education with the Triadic Teaching Approach as designed in Table 1. For this purpose, word association test which is utilized to ascertain cognitive structures of students and reveal concepts and connections between those concepts perceptively used as a pre and posttests together with a pre-implementation and a post-implementation drawings of concept network maps of students. As a result of this study, it is concluded that number of the answers by prospective teachers to the selected key concepts is increased as outlined in the Table 2. Word associations of students were increased by 54% in global warming concept, by 78% in ozone layer concept, by 61% in air pollution concept and by 67% in acid rains concept. In addition, further analyses carried out

with the data acquired (Table 3) revealed that pre-test mean scores of prospective teachers is found to be $\bar{X} = 15,7$, whereas post-test results found to be $\bar{X} = 29,3$ and t-test results conclude that there is a meaningful differentiation between pre and post test scores ($t = -10,8$, $p < 0.05$). These results proved the effectiveness of the Triadic Teaching Approach in teaching selected environmental subjects. Findings are in accordance with the findings of previous researches claiming meaningful learning is established by utilization of word association tests (Shavelson, 1974; Tao, P. K., and Gunstone, R. F. 1999; Bahar et al. 1999; Cardellini and Bahar, 2000; Bahar and Hansell, 2000; Bahar, 2003; Yalvaç, 2008; Nakiboğlu, 2008; Ercan, et al., 2010). In addition to these findings, examination of concept network map drawings outlined in Figure 1 and 2 revealed that meaningful learning is achieved and key concepts are associated between each other and with the answered words by the prospective teachers. These results were confirmed by many research findings stating that changes in the cognitive structures of students is established perceptibly by utilization of concept network map drawings (Bahar and Özatlı, 2010; Yalvaç, 2008; Ercan, et al., 2010; Yalvaç and Doğan, 2011). As a result of this study, it can be concluded that the contribution of the Triadic Teaching Approach to meaningful learning of selected environmental subjects is confirmed by use of word association test and drawing of concept network maps.

In addition, interviews done with prospective teachers on the effectiveness of the Triadic Teaching Approach revealed that by internet-web based online researching, 78% of the prospective teachers stated that they improved their skills in researching in the library, 72% stated that they have learned how to make online research, 70% stated that they have improved their skills in analyzing scientific publications and 66% stated that the approach has helped them to conceptualize the subject. These findings confirm that the Triadic Teaching Approach is effective in improving the skills of researching, reviewing literature and reading scientific publications of prospective teachers.

By poster activities and poster preparation of the Triadic Teaching Approach process, 80% of the prospective teachers stated that they have learned how to prepare posters, 75% stated that the process has allowed them to improve their creativity, 70% stated that the subjects are related with real life, 68% stated that they improved their skills of computer usage and 65% stated that learning by doing has occurred. These findings confirm that the poster preparation of the Triadic Teaching Approach is effective in teaching the subject, achievement of real life related learning, gaining skills in use of educational technology means and improving creativity. Such findings of this study are in accordance with findings of previous studies on poster activities (Dunstan and Bassinger, 1997; Sisak, 1997; Moule et al., 1998; Brown, S. and Burroughs, E., 2008; Kaya et al., 2009). In a similar study, we had concluded that the attitudes towards subjects of the science-technology-society course were positively developed (Kaya et al., 2009). Similarly, Paris and Glynn (2004) concluded that the use of posters in teaching is increased noticeability and eased learning. McHale (1994) and Akister, J. et al. (2000) concluded that by use of posters, effective learning is achieved and that students get the chance of learning while having fun.

By the mini-symposium activity of the Triadic Teaching Approach process, 80% of the prospective teachers stated that they have developed the sense of responsibility, 75% stated that the process has enabled them to learn the subject, 74% stated that the activity made them feel like a scientist and 70% stated that their ability of making a presentation to an audience is improved. About the use of means of educational technology, 80% of the prospective students stated that they have learned to reach online scientific sources, 76% stated that their computer and

internet skills are improved and 70% stated that they feel educational-technologies wise better equipped teacher candidates.

As a result, findings of this study revealed that the Triadic Teaching Approach is found to be effective in providing meaningful learning in selected environmental subjects, gaining skills in use of educational technology means and helpful to understand experiences of scientists.

RECOMMENDATIONS

The Triadic Teaching Approach which have an important place in developing the students' critical skills such as reviewing the literature and organizing the data the applications can be performed by taking part in the science curriculum.

Performing Triadic Teaching Approach for other disciplines such as physics, chemistry, biology, social sciences and mathematics the meaningful and permanent learning can be provided.

Taken place to the techniques concretely identifying the learners intellectual structure such as word association test and concept map in the process of learning and teaching, it can be found whether the meaningful learning can occur or not.

The Educators, considering the students cognitive style and intellectual structure organize the educational activities for elementary school.

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