

What Pre-service Science Teachers Say but What They Really Mean Regarding the Theory of Biological Evolution¹

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ABSTRACT The aim of the present study was to find out whether the pre-service teachers' perception of biological evolution theory is affected after attending an evolution course that specifically addresses the perceptions and acceptance of the theory. The study was designed as a qualitative phenomenological study. Data were obtained from document analyses from self-report questionnaires. Ten descriptive categories were outlined, namely *evolution is related to change and development, evolution is related to the diversity of life, evolution is related to the process of life coming into being, evolution is based on scientific data, evolution has not been proven, evolution has been proven, evolution is independent of religious belief, evolution is related to religious belief and there is no evolution*. It was seen that knowledge of evolution changed after participating in a course, but perceptions on evolution did not change.

INTRODUCTION

The theory of evolution is important in establishing connections between biological concepts and it provides an explanation for relationships between living things. By interpreting past and future events, the manner and degree of relationship between all living things in the world today is revealed, and a general meaning of change is given to evolution with explanations of hereditary transfer from one generation to another and how the current diversity of life occurred (Demirsoy 1984; Sengun and Ulakoglu 1992; Futuyama 2008; Campell and Reece 2010). Unfortunately, organisms do not change on a daily basis. In the Science program, starting from the knowledge that 'the smallest structural unit in all living beings is the cell', a concept arises for which various topics need to be taught, such as biodiversity, the adaptation of living beings

and endangered animal species. Teachers serve as an important link between scientists' and the public's understanding of biological evolution (Nehm and Schonfeld 2007). Teachers attitudes towards evolution have significant effect on practice (Mangahas 2017). Looking at the existing research outcomes, there are studies which have evaluated perceptions related to natural selection, adaptation and mutation (Nehm and Schronfeld 2007), and which have investigated the attitudes of university students towards the theory of evolution (Apaydin and Surmeli 2006; Annac and Bahcekapili 2012), as well as studies which have emphasized the direct teaching of evolution in Science education, or to have completely structured courses plans for teaching evolution (Koksal and Aslan 2007; Baumgartner and Duncan 2009; Wiles and Alters 2011). There appear to be no reports of the effectiveness of course designed to address suspected factors which may influence pre-service science teachers' perception of evolution. Some studies have revealed that some biology and science teachers do not accept the idea of evolution and some of whom have negative and low attitudes towards teaching of evolution theory (Ozturkler 2005; Asghar et al. 2007; Kahyaoglu 2013). So, when giving classes, the opinions of teachers regarding evolution affect the perceptions of those students (Nehm and Reilly 2007; Koksal and Aslan 2007;

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Kilic 2012). Moreover, Ozturkler (2005) assumed that evolution course may even be rejected or totally barred via the activities of teachers' organizations, textbook writers, and individual teachers. In Turkey, it is necessary to put forth what it means to understand the extent of evolution. There is a need to work more in this direction so that the underlying causes can be better explored. This situation shows the need to determine the perceptions of teachers towards the concept of evolution. If pre-service teachers' perception of evolution can be carefully explored, it will assist educators to promote their learning outcomes.

Objectives

This present study aimed at determining whether the perception of biological theory of evolution of pre-service teachers is affected after attending a course that specifically addresses evolution to clarify the perceptions and acceptance of the theory.

METHODOLOGY

The study was designed as a qualitative phenomenological study. Phenomenology is focused on individuals' meaning-making as the quintessential element of the human experience. The important findings derived from phenomenology are an understanding of a phenomenon as seen through the eyes of those who have experienced it (Patton 2014). This design helps to reveal individual perceptions related to a specific phenomenon.

Research Working Group

This study was conducted after autumn terms between 2010 and 2013 at the Faculty of Education, Uludag University in Turkey. The purposeful sampling strategy was used for the study. The participants were selected via criterion sampling, a type of purposive sampling (Patton 2014). The study group comprised volunteers in their final year pre-service science teachers who were due to attend the evolution course. This course is part of the science teacher education program and is intended to help prepare them to teach key stage 4 science in Turkey. The questionnaire was answered by the voluntary pre-service science teachers before and after attend-

ing the evolution course. Some students did not respond to the questions after the evolution course (n=44). One hundred and twenty four students, who had not completed the evolution course responded to the questionnaire while data collection was completed at three waves (in the year 2010, n=56; 2011, n=40; 2012, n=28) and the number of students who had gone through the evolution course was 80 (2010, n=30; 2011, n=20; 2012, n=30).

Education Content

Evolution as a whole theory in Evolution education is defined under eight basic headings, emphasizing natural selection, evolution of species over time, the diversity of living beings, a common ancestor, speciation, evidence of evolution, the rate and direction of evolution and human evolution. The National Research Councils' (1998) course plan including these basic headings was applied in this study. The evolution courses were programmed for 12-week period, two hours per week. Specific topics were presented by the researcher such as current news, issues from daily life and a discussion method was used with the students. The researcher maintained complete objectivity during the education to avoid any bias. The course was based on scientific evidence. The topic of human evolution was not given as a separate course in the study, as this would require determining the lineage of humans before evolution in all other living beings. Therefore, human evolution was considered by making a generalization that all living beings come from a single cell, within the topic of biological diversity and evidence was provided through systematics.

Data Collection and Analysis

Data was obtained from document analyses from the self-report questionnaires. Questionnaires were in an economic data collection instrument which allow respondents to answer in their own words, explain and qualify their responses and avoid the limitation of pre-set categories of responses (Visser et al. 2000; Glasow 2005). Glasow (2005) implies that '*Written surveys require minimum resources and allow the respondent the greatest latitude in pace and sequence of response*'. A self-report questionnaire was prepared to determine how the pre-

service science teachers perceived the idea of evolution. The basic questions designed to reveal their own perceptions were, *define evolution* and *what are your views on evolution?* Question 1 queried the respondents' cognitive knowledge of evolution, while Question 2 queried their perception on it. The first question allowed respondents the opportunity to relay their knowledge on the subject, while the second question gave opportunity for more personal expression. According to Bertrand and Mullainathan (2001), *'Whether question x is preceded by question Y or vice versa can substantially affect answers. Prior questions may elicit certain memories or attitudes, which then influence later answers'*. Participants were given 50 minutes to answer the questions. Thematic analysis was employed in order analyze the data obtained through document analysis of the statements made by the students in their own sentences. Regarding the evaluation of the responses of the pre-service science teachers to the questions, first all the responses were read quickly in one session. Primary categories were formed by comparing the similarities and differences in the statements of the individuals. Some categories were changed after a second review of the data and definitive categories were formed thereafter. After the third reading, the main list

of the temporary primary categories became categories of description. Within the significance of the research findings, communicative validity agreement between researchers reached through discussion was checked (Akerlind 2005). For dialogic reliability, the categories of description were confirmed through a discussion with two expert researchers. During the discussion, the categories of description were categorized separately as suitable, not suitable and may remain. Only the ones accepted as 'suitable' as a result of the specific evaluation were employed in the study. The perceptions of the pre-service science teachers who had and had not attended the evolution courses were classified according to the descriptive categories. The percentages and frequency values were calculated and presented in table format.

RESULTS

In this study, 10 descriptive categories emerged as elements of perception, regarding evolution, from the perspectives of pre-service teachers. There was no special ranking done for the ordering of the descriptive categories. The descriptive categories, the means of description and the category explanations are shown in Table 1.

Table 1: The categories and means of description of evolution theory given by the pre- service teachers

<i>Categories of description</i>	<i>Way of description</i>	<i>Way of experienced</i>
Evolution is related to change and development	Evolution described as change and development	Explained by association with change and development
Evolution is related to the diversity of life	Described as diversity of life	Explained as associated with diversity of life
Evolution is related to the process of life coming into being	Evolution described as the process of life occurring	Explained by association of the process of life occurring with evolution
Evolution is based on scientific data	Evolution defined as based on scientific data	Evolution explained by statements thought to be scientific and concepts of the nature of science.
Evolution has been proven	Evolution described as supported by evidence	Explained with statements that evolution is valid and has been proven.
Evolution has not been proven	Evolution described as not supported by scientific evidence	Explained with statements that evolution is not true or not certain as it has not been proven.
Evolution is independent of religious belief	Evolution described as independent of religious belief	Explained with statements that evolution is independent of religion and belief because science and religion are separate.
Evolution is related to religious belief	Evolution described as related to religious belief	Explanations stating that evolution has an origin related to religion and belief and is consistent with my beliefs
There is no evolution	Description that evolution does not exist	Explanations stating that there is no evolution and the concept is not believed.

According to Table 1, declarative based knowledge factors (*related to change and development, related to diversity of life, related to the process of life occurring*) scientific knowledge factors (*based on scientific data, proven, has not been proven*), religious beliefs factors (*related to religious faith, independent of religious faith*) and *there is no evolution* are clearly seen in the perception of the theory of evolution by pre-service science teachers.

To clarify whether the perception of the pre-service science teachers changed after they had gone through the evolution courses, both groups were evaluated in conjunction with categories of description. To reveal the perception of the pre-service teachers to the evolution theory, they were asked the following questions “Define evolution (Q1)” and “What are your views on evolution (Q2)”, the responses to the questions according to categories of description are shown in Table 2.

According to Table 2, differences are seen between the forms of definition and the perceptions of evolution of the pre-service teachers. Evolution was defined as mostly *change and development* by 76.6 percent of pre-service teachers who had not attended the evolution course and 69.1 percent of students who had attended the evolution courses. But their perception on evolution was described as *not proven* by 66.9 percent of pre-service teachers who had not attended and 64.2 percent of students who had attended the evolution courses. Another noticeable result which was the perception that evolution is based on scientific knowledge factors was seen to be greater after they had had the evolution course (56.8%).

Percentage response according to the pre-service teachers’ definition of evolution (Q1) who

had or had not attended the evolution courses is given in Figure 1. According to Figure 1, it is important to note that both pre-service teachers’ definitions for Q1 clearly differ. Surprisingly, of the pre-service science teachers who had attended the evolution course, the description that it is *related to the process of life occurring* and *based on scientific data* was declined dramatically. Therefore, the opinion that *evolution was proven* was seen to be greater. Percentage response according to the pre-service teachers’ views on evolution (Q2) who had or had not attended the evolution courses regarding the categories of description is given in Figure 2.

According to Figure 2, some differences were seen in the view on evolution between those who had and had not been in the evolution courses. Another noticeable result was that those who had taken the evolution course did not think evolution to be independent of religion. Therefore, the opinion that evolution was not proven was seen to be greater. Besides, it can be said that their perceptions of evolution did not change significantly after taking the courses.

DISCUSSION

In this research, pre-service science teachers’ perceptions regarding evolution were explored using quantitative analyses. Answers to the given questions were analyzed and it was seen that pre-service science teachers’ acquired the knowledge about evaluation during the course, but their perceptions on it did not change. According to the literature on it, students’ understanding of the theory of evolution is more important than the students’ acceptance of it (Scharmann 1994; Asghar et al. 2007; Wiles

Table 2: Frequency table of the responses to Q1 and Q2 of the pre-service teachers who had and had not received evolution lessons according to the category of description

Categories	Responses			
	Pre-Q1	Post-Q1	Pre-Q2	Post-Q2
Related to change and development	76.6% (n=95)	69.1% (n=56)	14.5% (n=18)	23.5% (n=19)
Related to diversity of life	28.2% (n=35)	25.9% (n=21)	36.3% (n=45)	45.7% (n=37)
Related to the process of life occurring	58.9% (n=73)	23.5% (n=19)	2.4% (n=3)	9.9% (n=8)
Based on scientific data	44.4% (n=55)	14.8% (n=12)	52.4% (n=65)	56.8% (n=46)
Proven	-	1.2% (n=1)	1.6% (n=2)	4.9% (n=4)
Not proven	10.5% (n=13)	1.2% (n=1)	66.9% (n=83)	64.2% (n=52)
Independent of religious faith	0.8% (n=2)	-	2.4% (n=3)	-
Related to religious faith	1.6% (n=2)	1.2% (n=1)	19.4% (n=24)	19.8% (n=16)
There is no evolution	1.6% (n=2)	-	14.5% (n=18)	12.3% (n=10)

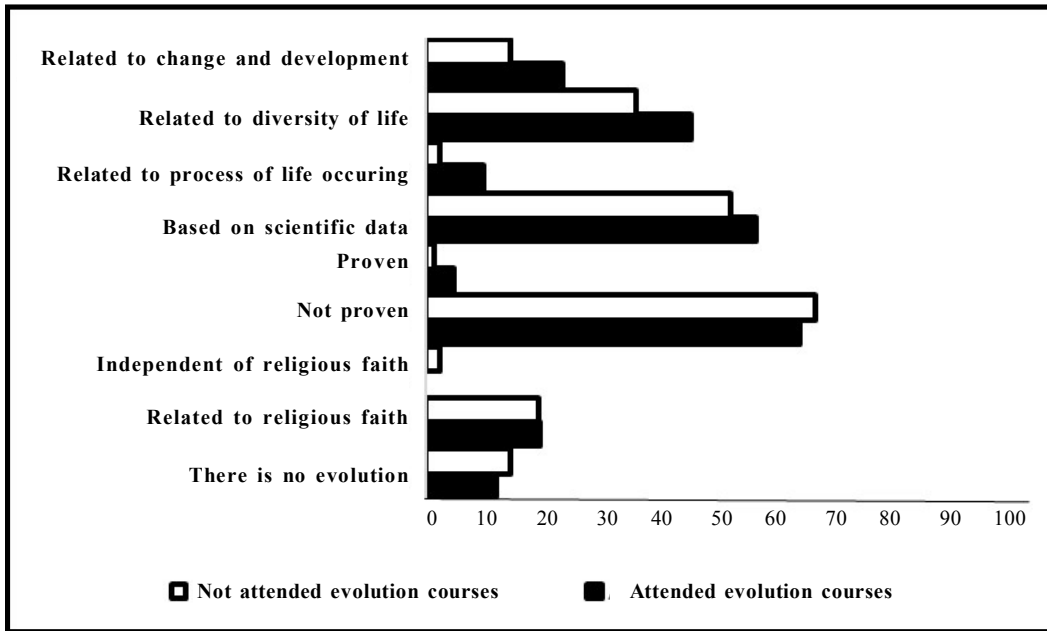


Fig. 1. Percentage response according to the pre-service teachers' definition of evolution

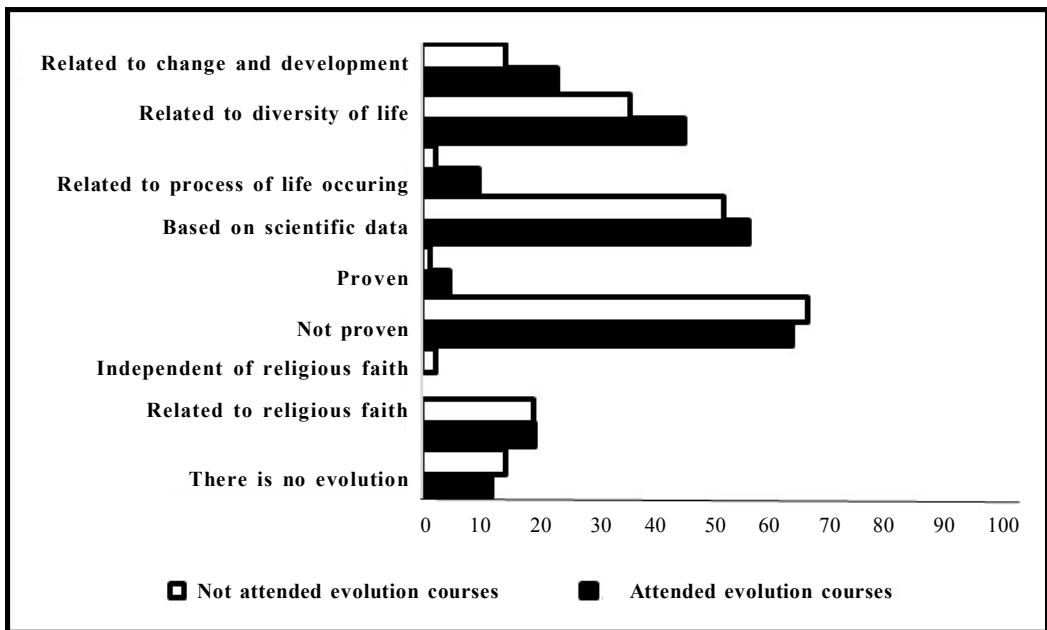


Fig. 2. Percentage response according to the pre-service teachers' views of evolution

and Alters 2011). This signifies that accepting evolution does not mean understanding it. Students might describe evolution correctly but at the same time might not accept it. Therefore, students' perceptions regarding evolution are not only related to the knowledge of evolution. Sinatra et al. (2003) found that knowledge of evolution was not related to acceptance of evolution theory in some instances. In this research, pre-service science teachers failed to accept evolution as a theory of science. When the results of the participants' response were evaluated, it was obvious that the strongest perception related to the theory of evolution was that *evolution has not been proven*. Despite being supported by scientific data, the respondents showed a conflict in their explanations associated with the theory not having been proven. This implies that, there is a sharp contrast to the view based on scientific data and not proven categories. Kahyaoglu (2013) implied that many of the pre-service teachers did not accept the theory of evolution as scientifically valid and the most common argument is that the theory of evolution has not been proven and is rejected. Irez and Ozyeral Bakanay (2011) stated that biology teachers' perception about the nature of science affect their perception about biological evolution. Teachers thought that the idea of biological evolution has a speculative nature, but it is not supported by adequate scientific evidence collected through scientific observations and experiments. Cavallo and McCall (2008) investigated students' beliefs about evolution and the nature of science in their understandings of evolution after instructions. Their research showed that students' beliefs or acceptance of evolution did not change during the course. It is thought that the main problem here is the lack of knowledge regarding the nature of Science (Akyol et al. 2012; Dagher and Boujaoude 2005; Irez et al. 2007; Scharmann 1994). In Turkey, the word 'theory' is defined commonly in daily life as a 'general idea or view' (Turk Dil Kurumu 2014). This creates a block in the scientific acceptance of the theory of evolution by pre-service teachers with incorrect perceptions of the concept of a theory (Irez et al. 2007; Annanc and Bahcekapili 2012; Apaydin and Surmeli 2006; Apaydin and Surmeli 2009; Gregory and Ellis 2009; Rutledge and Warden 2000). In addition, Asghar et al. (2007) pointed out that most pre-service elementary teachers seem to have a lack of understanding

of the most basic concepts in the science of evolution.

The present study provides support to literature reporting that religious beliefs affected the theory of evolution perception. Cavallo and McCall (2008) claimed that there are interrelationships between the concept of belief in evolution, nature of Science and one's understandings of evolution. Sinatra et al. (2003) assume that learners who view evolution as contrary to their held religious beliefs with regard to their emotional demands directly conflict with their scientific explanations of evolution. As discussed earlier, various studies have shown that teachers' and students' religious opinions of creation, that is, their beliefs influence their scientific understanding of evolution (Dagher and Boujaoude 2005; Rutledge and Warden 2000; Woods and Scharman 2001; Vlaardingerbroek and Roederer 1997). Kahyaoglu (2013) mentioned that pre-service science teachers' concept of evolution theory is complex and difficult, and their religious perspective is a little reverse in Turkey. According to da Silva et al. (2015) teachers' belief in 'creation' might affect the explanations of biological knowledge, how students discover biology and there is a risk of introducing conceptual misunderstanding. Mangahas (2017) found that teachers' religious beliefs affected their teaching of evolution. Moreover, their religious beliefs negatively influenced their understanding of evolution and the nature of science.

CONCLUSION

This study indicated that some students maintain that the theory of evolution is just a theory not a law. Despite the lack of perception in the study of beliefs at the level of knowledge, it seems that this has occurred in students' perceptions. Belief is shaped at an early age and can create resistance in the acceptance of certain concepts of the person. According to the findings of the study, in contrast to evolution education being discussed, it has been distanced in teachers' minds because of beliefs. Therefore, it may be inferred that the views of the pre-service teachers related to the diversity of life and the process of life occurring, originate from a common source, and have shifted towards a creationist view. When it is considered as that, because the evolution courses of

common-ancestor approach is a process leading to an absolute single being, it is not contrary to religion but actually supports religious opinion and should be evaluated from the aspect of content leading to an absolute single being. The result of this study assumed that pre-service teachers' description on evolution is generally related to declarative knowledge factors but perception on evolution is highly affected by scientific knowledge and religious belief factors.

RECOMMENDATIONS

This study was conducted with university students with definite views and who were close to graduation at the time the evolution course was delivered. After a definite perception has been formed and religious beliefs are held to, it is not easy to change these, regarding evolution. When considered in terms of education, placing the evolution course at an earlier time in syllabus, and correct teaching of the nature of science would contribute to a reduction in the perception that evolution is unproven scientific knowledge. In the classroom, a teacher's role is to motivate his/her students to accept evolution as scientifically valid and students should be able to distinguish between scientific and non-scientific knowledge.

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