

## **In-service Turkish elementary and science teachers' attitudes toward science and science teaching: A sample from Usak province**

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**ABSTRACT:** The purpose of this study is to reveal Turkish elementary teachers' and science teachers' attitudes toward science and science teaching. The sample of the study, 138 in-service elementary level science teachers from a province of Turkey, was selected by a clustered sampling method. The Science Teaching Attitude Scale-II was employed to measure the attitudes of the teachers. It was found that in-service elementary level and science teachers had positive attitudes toward science and science teaching. They accept scientific theories as uncertain changeable truths while scientific laws are perceived as unchangeable certain truths. They also have problems in understanding the acquisition of scientific knowledge—either from observations and experiments or from authorities. For science teaching, they agree on the use of a student-centered approach for teaching science courses. On the other hand, they strongly support a teacher-centered approach at the same time. The means of the sub-scales of STAS-II in this study showed very strong similarities to the previous studies that used STAS-II in Turkish context.

**KEY WORDS:** elementary science teacher education, attitudes toward science and science teaching, Turkey

### **INTRODUCTION**

The latest Turkish science curriculum for primary schools has underlined major aspects of science education, such as becoming scientifically literate citizens or students, being aware of science process skills, hands-on science or science for every-day living and having positive attitudes toward science (Ministry of National Education, 2004, and 2013). Despite giving special attention to science education in the latest science curriculum, like many parts of the world, science education still seems to have some cognitive and affective problems in Turkey, such as low achievement, dislike, and difficulty of science courses.

From these perspectives, science educators and researchers strive to look deeply into these problems to find out what the reasons are behind them. Of course, there are many different reasons for the problems mentioned above but one of the most important reasons seems to be the

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students' low interest and negative attitudes toward science courses (Jelinek, 1998). Haladyna, Olsen and Shaughnessy (1982) and Rodrigues, Jindal-Snape and Snape (2011) mentioned that students' feelings toward science courses, students' decisions about their future career choices, and students' achievement in science courses were correlated with their attitudes toward science. The studies of Oliver & Simpson, 1988 and Shriley, 1990 support these findings that attitudes toward science are one of the strongest predictors of students' achievement in science.

Attitudinal studies on science have emphasized four main areas. The first main area includes elementary, middle, and high school students' attitudes toward science; cross-sectional studies; the effects of science courses; special science field experience; visits to science related areas (Jarvis & Pell, 2004); and the trends over time during school years from the beginning grade levels through to graduation (Gibson & Chase, 2002). The second main area encompasses the studies of attitudes of college students who are in an elementary or science education area, of pre-service elementary or science teachers, and of in-service elementary and science teachers toward science as well as science teaching (Ediger, 2001; McGinnis & Parker, 1999; Turkmen, 2002a). Studies in the third main area compare attitudes of students and teachers from different countries toward science (Ye, Wells, Talkmitt, & Ren, 1998). Finally, the fourth main area is comprised of correlation studies of students' and elementary and science teachers' attitudes toward science and science teaching with factors such as gender, achievement levels, and some socio-economic factors (Weinburgh, 2000).

In science education, it is generally accepted that elementary and science teachers' attitudes toward science and teaching science have an important role due to the influence of teacher characteristics on students. Therefore as a prerequisite to successful teaching, science teachers, pre-service science teachers, or science teacher candidates have to understand the nature of science. They also have to be able to convey these aspects of science to their students. Studies show that if science teachers apply the nature of science and improve students' attitudes toward science, students increase their achievement in science courses (Osborne, J., Simon, S. & Collins, S., 2003; Brickhouse, 1992; Bloom, 1989; Friend, 1985; Gabel, 1980; Moore, 1973; Moore & Foy, 1997; Munby, 1983). Even today, in many schools, the teaching of facts and related concepts is the characteristic of science teaching. As indicated in National Research Council (1996), science teachers need to include the scientific attitudes, and the nature of science and increase students' positive attitudes toward science so that as science educators or teachers, we can foster scientifically literate citizens who apply and connect basic science concepts into their daily life or who can coordinate science, technology, and society (Turkmen, 2008). Our century is and will be an information

and technology age. If we are unaware of scientific concepts, we will not be apart of competing with others or surviving in the next century (Koballa & Crawley, 1985). That is why in science education and science teacher preparation, increasing positive attitudes toward science and understanding and possessing scientific attitudes are important for science teacher candidates. In developing countries, like Turkey, emphasizing teaching science (general science, biology, physics, chemistry, and earth science); understanding the nature of science; possessing scientific attitudes; and positively changing students' attitudes toward science are important for everyone, especially for the young and the next generation.

Recently, there have been a number of studies concerning some international aspects of attitudes toward science but mostly they are comparisons of US and Chinese high school and college students' attitudes toward science. These studies found more differences based on the nationality than grade levels and gender (Rodrigues, Jindal-Snape and Snape, 2011; Lee 1993; Sensales and Greenfield, 1995; Staver and Wang and Staver, 1997; Ye et al. 1998). On the other hand, it is easily seen that there is a lack of studies dealing with elementary school teachers and teacher candidates' attitudes toward science and science teaching in the other parts of the world (Turkmen, 2007). At this point, studies of attitudes toward science should be extended to the other countries with the different aspects of attitudes toward science. It is also received that it is more than a necessity to conduct this kind of research.

Two major studies about Turkish science and elementary students' attitudes toward science and science teaching were conducted by Turkmen (2002) and Turkmen (2008). An attitudinal scale "Science Teaching Attitude Scale-II" (STAS-II) developed by Moore & Sutman (1970) and later revised by Moore & Foy (1997) was employed to conduct those studies. Instead of college students' attitudes toward science and science teaching whose majors are science and elementary education, there is a need to conduct research on the attitudinal characteristics of in-service science and elementary teachers in the Turkish context because of the lack of comprehensive studies on the attitudes toward science and science teaching including all of its aspects.

### ***The purpose of study***

The purpose of the study is to determine the attitudes of in-service science and elementary teachers toward science and science teaching and compare the findings of previous studies that have used the same scale (STAS-II) in a Turkish context. The reason to choose in-service science and elementary teachers is that currently, science courses have been taught by elementary teachers in elementary schools and science teachers in middle schools in Turkish context.

The major research questions to be answered in this study are the followings:

1. What are the attitudes of in-service science and elementary teachers from a selected province of Turkey toward science and science teaching?
2. Do the attitudes toward science and science teaching of in-service science and elementary teachers have statistically significant differences related to the gender, school type that they graduated from, teaching experience, the number of science and science teaching courses taken as students, and the education levels of their parents?
3. Do the attitudes toward science and science teaching of in-service science and elementary teachers show any similarities when compared to the previous studies that employed the same attitudinal scale (STAS-II) in a Turkish context?

### **THEORETICAL FRAMEWORK**

Throughout the world, from the elementary schools to colleges, science is one of the major subject studies. Currently, main objectives of science courses can be summarized as fostering scientifically literate people who are capable of using science process skills and who have positive attitudes toward science. For that reason, for more than nine decades, attitudes toward science have been one of the main research areas in science education.

One of the early scales called “A Test for Scientific Attitude.” to measure attitudes was developed by Hoff (1933). After the 1960’s, the number of tests measuring scientific attitudes and attitudes toward science increased. Some of them were widely used to reveal the attitudes of middle school, high school and college students as well as elementary and science teachers.

In the following years, different scales developed by researchers have begun to be used to measure attitudes related to science and toward science. More (1973) developed one of the most commonly used scales to measure attitude toward science and science teaching called ‘Scientific Attitude Inventory’ (SAI) and Science Teaching Attitude Inventory (STAI). However, under the criticism of Munby (1983), SAI and STAI were revised and improved by More and Foy (1997). The latest version of STAS-II (Science Teaching Attitude Scale-II) was translated into Turkish in order to use it for measuring Turkish Pre-service Science Teacher Candidates’ attitudes toward science and science teaching by Turkmen (1999).

### ***Some factors related with attitudes toward science***

#### *Gender*

Attitudes toward science are shaped by different factors such as ability, motivation, quality of instruction, the content of courses, teachers' personalities, home and school environments, the place students live, race and gender. Gender seems to be one of the important predictors of students' achievement in science learning and attitude toward science (Shamai, 1996; Welch, Welberg, & Fraser, 1986). Gender-related research indicates that boys favor science courses as well as science related jobs such as engineering more than girls (Cavas and others, 2011; Faye, 1997; IAEP, 1992). An international study conducted by the International Assessment of Educational Progress (IAEP) including 20 countries and students from nine to thirteen-year old students found that there was a considerable gap between male and female students for their attitudes toward science and science teaching in the participating countries except for Taiwan and Jordan. In those countries, boys preferred mostly mathematics and physics courses while girls tended to take biology courses (IAEP, 1992; Shibeci, 1984). The same findings have also been in other studies where males had more positive attitudes toward science than girls. According to the report of Weinburgh (2000) and Simpson and Oliver (1985), boys had significantly more positive attitudes than girls among 4000 students studying at grade 6 through 10. Besides, Jones, Howe, & Rua (2000) presented similar results, to indicate that 6<sup>th</sup> grade female students felt science courses were more difficult to understand than male students did. This tendency affected choosing future careers by students which had resulted in 15% of the work force in science related areas being women (Chapman, 1997).

#### *Some Socio-Economic Factors*

Other than gender, achievement and grade levels, there are also some factors regarding the relationships of attitudes toward science such as environment, ethnicity and the education level of parents included on the research agendas on the studies of attitudes toward science. Ethnicity-level studies conducted in the USA illustrate that while generally European-Americans favor science, African-American and Mexican-Americans do not.

In Turkish context, studies conducted by Turkmen (1999), Cavas and others (2011) reported important results among attitudes, career choices and some socio-economic factors. Turkish science teacher candidates' attitudes toward science and science teaching show no significant relations based upon some socio-economic factors, such as the education level of the parents and the income levels of their families. However, there

is a tendency that students' attitudes toward science seem to be more positive than the others when the level of education and the economic income levels of their parents increase. This point could be considered as an indirect environmental effect on attitudes toward science.

*Studies concerning attitudes toward science teaching*

Investigating the science teaching attitudes of the teachers who are responsible for teaching science in schools is important because the importance of promoting and developing students' attitudes toward science is crucial. Studies try to examine how teachers' attitudes have effects on students' interest, achievement, and attitudes toward science. General belief about the attitudes of teaching is that if teachers hold positive attitudes toward the teaching of a field or course, these positive attitudes have an impact on their ways of teaching. Positive attitudes also increase their motivation and enthusiasm for teaching (Pigge & Marso, 1997). Studies conducted on pre-service teachers or teacher candidates indicated that if student teachers have high grades and positive attitudes, they want to enter teaching area early (Villeme & Hall, 1980). The findings of Ramsay & Ransley (1986) support the idea that teachers with positive attitudes also influence student achievement. Other studies related to attitudes toward teaching in particular toward science teaching, have been concerned with the effect of science teaching method courses, science courses, student teaching experiences, longitudinal the differences of attitudes toward teaching across the grade levels (Ateaq, 1995; Gabel, 1980). Moore (1975) investigated another aspect of attitude toward science teaching that whether particular science teaching methods courses as a summer workshop for elementary school teachers, had any effect. The results have indicated that some particular science teaching courses had increased attitudes toward science teaching but after a certain time the attitudes retained to the beginning level. Turkish pre-service science teachers' attitudes toward science and science teaching were investigated by Turkmen (1999). He found that pre-service science teachers in Turkey held positive attitudes toward science and science teaching. In another study, pre-service elementary teacher candidates' attitudes toward science and science teaching between freshman and senior years showed no significant difference for a sample coming from an education college of Turkey, in a longitudinal perspective (Turkmen, 2008).

It could easily be seen that attitudinal studies concerning science teaching have mostly focused upon pre-service elementary and science teachers at the college level and not upon in-service teachers holding science teaching duties in the schools. In fact, pre and in service science and elementary school teachers' attitudes toward science and science teaching are not at a satisfactory level from the international perspective. It would be expected that this gap would be filled with the new attitudinal

studies from the international arena. Therefore, it is important to investigate the attitudes of in-service elementary and science teachers' attitudes toward science as well as science teaching in a Turkish context.

## **METHOD**

### ***Sample***

This study is a cross-sectional design to investigate the attitudes towards science of in-service elementary and science teachers who were currently teaching science courses in primary schools from grades 4 through 8 in the province of Usak, located in the western part of Turkey. The sample for the study consisted of 95 in-service elementary and 38 in-service science teachers who were selected using a clustered sampling method from a population of 350 in-service elementary and 85 science teachers in Usak province.

### ***Instrument***

The Science Teaching Attitude Scale II (STAS-II) was used in this research to measure in-service elementary and science teachers' attitudes toward science and science teaching. Although the original form of the scale was in English (Moore & Foy, 1997), it was necessary to translate the STAS-II into Turkish for the Turkish context. Therefore, the researcher (whose native language is Turkish) translated the instrument into Turkish. Before using the Turkish version of the STAS-II, it was retranslated into Turkish by a native Turkish Ph.D. student in the area of English literature without previous knowledge of the test. This back translation was compared by native English speaking academic researchers with the original English version of the STAS-II. Their final conclusion was that the two versions had the same meaning.

The STAS-II has 60 statements related to science and science teaching. These statements are rated using a Likert-type scale and consist of 30 positive and 30 negative statements. The statements are also evenly divided to measure attitudes toward science and toward science teaching. They are also classified under eight main sub-scales, five of which are attitudes toward science and three of which are attitudes toward science teaching. Each sub-scale also has two additional sub-scales with positive (A) and negative (B) portions. Therefore, the number of sub-scales is 16. All statements are assigned to these 16 sub-scales. Each sub-scale in the science attitude portion has three statements and in the teaching attitude portion each sub-scale has five statements.

### ***Reliability***

The reliability and validity of the English version has been reported in the literature (Moore, 1973; Moore & Foy, 1997; Moore & Sutmann, 1970). In addition, the reliability coefficient of the Turkish version of STAS-II was found to be Cronbach's Alpha  $\alpha=0.78$  for this study.

### ***Data gathering and analysis***

After getting necessary permission from the Ministry of National Education of Turkey to conduct this study, the instrument was directly given to the in-service elementary and science teachers with the written explanation of the instrument. Additional information such as gender and teaching experience was also collected. The responses of the teachers were converted to the computer environment. Finally, when the mean of an item is higher than 3, the attitude was classified as positive attitude toward science and science teaching and, if the item score mean is less than 3, it is classified as negative. In the following, the attitudinal scores of in-service elementary and science teachers toward science and science teaching are separately reported for science and science teaching. Moreover, the attitudinal scores of the sub-scales A's (positive statements) and B's (negative statements) were calculated for each sub-section (science and science teaching). The results were firstly examined whether in-service elementary and science teachers have positive attitudes toward science and science teaching based upon the scales and later the sub-scales. In the cases of attitudinal differences based on some factors, such as gender and other socio-economic factors, the data were analyzed with ANOVA ( $\leq 0.05$ ) and Tukey test if necessary with a post-hoc test as well as some supplemental descriptive statistical procedures. Finally, the results of this study were compared with that had previously studies used the same instrument in a Turkish context.

## **RESULTS**

The major research questions mentioned previously were addressed through the data analysis. The first research question related to whether in-service elementary and science teachers have positive attitudes toward science and science teaching. The frequency distributions and the average item means of in-service elementary and science teachers' attitudes toward science and science teaching can be seen in the following Table.



**Table 1. The Average Item Mean Standard deviating and sample size (n) of In-service Elementary and Science Teachers' Attitudes Toward Science and Science Teaching.**

<b>Attitudes toward</b>		<b>Science</b>	<b>Science Teaching</b>
Total	M	3.37	3.33
	n	133	133
	<b>SD</b>	<b>.22</b>	<b>.26</b>

The results show that the attitudes of in-service elementary and science teachers could be accepted as positive toward science and science teaching due to an average mean slightly greater than 3,00.

When we look at the frequency distributions, only five teachers out of 133 teachers have negative attitudes toward science and only 6 teachers out of 133 had negative attitudes toward science teaching in both two sections since their mean scores are below the cutting point of 3.

The mean item scores for teachers' attitudes toward science and science teaching seem to be very close to each other.

As mentioned above, the STAS-II first has two parts (science and science teaching) and every part has its own sub-scales. First, the sub-scales of STAS-II 1 through to 5 deal with attitudes toward science and also each sub-scale has two parts as positive and negative parts (opposite to each other). In the following table, in-service elementary and science teachers' attitudes toward science as shown in sub-scales were stated.

**Table 2. The Average Item-Mean Scores for In-Service Elementary and Science Teachers' Attitudes Toward Science In Sub-Scales**

Sub-scales	General Contents Of Sub-Scales In Attitudes Toward Science	Mean	Std. Deviation
<b>1-A</b>	The laws and/or theories of science are approximations of truth and are subject to change.	3.90	.65
<b>1-B</b>	The laws and/or theories of science represent unchangeable truths discovered through science.	2.74*	.65
<b>2-A</b>	Observation of natural phenomena and experimentation is the basis of scientific explanation. Science is limited in that it can only answer questions about natural phenomena and sometimes it is not able to do that.	3.74	.68
<b>2-B</b>	The basis of scientific explanation is in authority. Science deals with all problems and it can provide correct answers to all questions	2.57*	.62
<b>3-A</b>	To operate in a scientific manner, one must display such traits as intellectual honesty, dependence upon objective observation of natural events, and willingness to alter one's position on the basis of sufficient evidence.	3.93	.73
<b>3-B</b>	To operate in a scientific manner one needs to know what other scientists think; one needs to know all the scientific truths and to be able to take the side of other scientists.	3.94	.76
<b>4-A</b>	Science is an idea-generating activity. It is devoted to providing explanations of natural phenomena. Its value lies in its theoretical aspects.	3.99	.64
<b>4-B</b>	Science is a technology-developing activity. It is devoted to serving mankind. Its value lies in its practical uses.	1.99*	.63
<b>5-A</b>	Progress in science requires public support in this age of science; therefore, the public should be made aware of the nature of science and what it attempts to do. The public can understand science and it ultimately benefits from scientific work.	3.66	.72
<b>5-B</b>	Public understanding of science would contribute nothing to the advancement of science or to human welfare; therefore, the public has no need to understand the nature of science. They cannot understand it and it does not affect them.	3.25	.66

\* lower than 3,00

To avoid ambiguity of the sub-scales of STAS-II, it is necessary to put extra information here. B sections of the sub-scales reflect the opposite of A sections so that the expected results are to give positive responses (strongly agree (5 point) and agree (4 point) choices) in A sections and negative responses (strongly disagree (5 point) and disagree (4 point))

choices) in B section. Therefore, in B section when the mean is lower than 3 point, it should be thought that they agree with the statements of B section. Besides, if the means of each sub-scale of A and B parts are close to each other, this means that they are consistent with each other. Especially, if the means of a sub-scale are lower than 3 (neutral choices coded as 3), their attitudes to a particular sub-section in science are classified as negative.

In sub-scale 1 A and B, it seems to have a problem that in-service elementary and science teachers accept that scientific theories and laws are subject to change and not 100% true because the mean of sub-scale 1-A is close to 4. On the other hand, there is an inconsistency between 1-A and 1-B that they also think scientific truths are unchangeable. The same kinds of results could be also noticed between 2-A and 2B as well as between 4-A and 4-B (Table 2). However, the lowest mean (1.99 point) come from sub-scale 4-B that in-service elementary and science teachers see science as technology developing activity while at the same time they accept that the function of science would be the explanations of natural phenomena ( the mean of sub-scale 4-A is 3.99 point).

**Table 3. The Average Mean Of In-Service Elementary and Science Teachers' Attitudes Toward Science Teaching In Sub-Scales**

Sub-scales	General Contents of Sub-scales in attitudes toward teaching	Mean	Std. Deviation
6-A	The idea of teaching science is attractive to me; I understand science and I can teach it.	3.65	.62
6-B	I do not like the thought of teaching science.	4.14	.64
7-A	There are certain processes in science which children should know, i.e., children should know how to do certain things.	3.71	.60
7-B	There are certain facts in science that children should know.	2.08*	.69
8-A	Science teaching should be guiding or facilitating of learning. The teacher becomes a resource person.	4.20	.53
8-B	Science teaching should be a matter of telling children what they are to learn	2.23*	.61

\*lower than 3 points

In-service elementary and science teachers' attitudes toward science teaching show that teachers responsible for teaching science in primary school like to teach science courses (Sub-scales 6-A and B). Like attitudes toward science, teachers perceive that science teaching would cover some certain processes and certain scientific facts (Sub-scales 7-A and 7-B). The same thing could be said for sub-scales 8-A and 8-B that in-service

elementary and science teachers see themselves as a guiding person and also as a telling person what students are to learn in science teaching.

Second research question deals with the answer of whether there are mean differences of attitudes toward science and science teaching based on some factors mentioned below. Three-factor variance analysis (ANOVA) was run to find the answer of the second research question by comparing attitudinal means of in-service elementary and science teachers based on gender, the types of school they graduated to become an elementary or science teacher, science teaching method courses that they took. In this study, there are additional factors such as the education level of teachers' parents, the number of years teachers taught science in schools. It was thought that they would have had significant effect on attitudes toward science and science teaching but after running one-way variance analysis; there were no significant mean differences observed for those factors. Therefore, these statistical results were not reported here due to lack of any observable significant mean difference.

The means and standard deviations of attitudes toward science and science teaching based on the gender, the education levels of teachers, and science teaching method course taken or not taken as well as their three-way analysis of variances were reported in Tables 4., 5., and 6.

**Table 4. Means and Standard Deviations of in Service Elementary and Science Teachers' Attitudes toward Science and Science Teaching by Gender and Education Levels**

Factors		Attitudes toward					
		Science			Science Teaching		
		N	M	SD	N	M	SD
Gender	Female	54	3.38	.22	54	3.28	.24
	Male	78	3.36	.23	78	3.37	.26
Education Level	Two or three-year college graduate*	72	3.29	.23	72	3.28	.25
	Four-year college graduate	61	3.46	.19	61	3.40	.25
Science Teaching Method Course	Yes	88	3.40	.22	88	3.36	.24
	No	44	3.32	.23	44	3.27	.29
Enrolled							
<b>Total</b>		<b>133</b>	<b>3.37</b>	<b>.22</b>	<b>133</b>	<b>3.33</b>	<b>.26</b>

\*Most of those teachers have completed their degree studies as associate or bachelor degrees by pursuing their education in an open university of Turkey but previously they graduated from a teacher high school or three-year college.

Before giving the results of three-way variance analysis, it is necessary to explain some results at this point. Male and female in-service elementary and science teachers' attitudes toward science are very close to each other but the same situation is not seen for the attitudes toward science teaching that male teachers' attitude toward science teaching is more positive than those female teachers' attitudes. Teachers' attitudes toward science as well as toward science teaching based upon the education levels of teachers show mean differences that the teachers who graduated from four-year colleges (higher institutions over high schools) have higher mean than those teachers who graduated from two or three-years colleges (higher institutions over high schools). (Generally, older teachers have a two or three-year college graduate degree and younger teachers have normal a four-year college graduate degree in Turkey). The similar results could be seen at the science teaching method course taken or not taken during formal college education years that the teachers who took science teaching method course have higher means than those who did not take (Table 4).

**Table 5. The results of three-way analysis of variance of in-service elementary and science teachers' attitudes toward science**

Source	SS	df	MS	F	Sig.
Gender (A)	.05	1	.05	1.08	.301
Education Level (B)	.76	1	.76	17.29	.001*
Science Methods Course Enrollment (C)	.03	1	.03	.62	.430
A * B	.05	1	.05	1.19	.278
A * C	.10	1	.10	2.26	.135
B * C	.00	1	.00	.04	.848
A * B * C	.05	1	.05	1.24	.268
Error	5.38	123	.04		
<b>Total</b>	<b>1494.10</b>	<b>131</b>			

\*P<.05

After running three-way variance analysis (ANOVA), only one significant main effect is observed that the attitudes of a four-year college graduate of in-service elementary and science teachers toward science have significantly higher mean than those of with a two or three-year college degree. The other factors, gender and science method courses taken or not, do not show any significant mean differences. As a result, the second null hypothesis which was no significant attitudinal mean difference toward science was partially rejected only for one factor (education levels of teachers) mentioned at the table 5 ( $F_{(1,123)} = 17.289$ ,  $p < .05$ ). The same

situation was evaluated by testing for attitudes toward science teaching and the result is reported in table 6.

**Table 6. The Results of Three-Way Analysis of Variance of In-Service Elementary and Science Teachers' Attitudes Toward Science Teaching**

Source	SS	df	MS	F	Sig.
Gender (A)	.43	1	.43	6.96	.009*
Education Level (B)	.25	1	.25	3.98	.048*
Science Methods Course Enrollment (C)	.14	1	.14	2.20	.141
A * B	.02	1	.02	.29	.596
A * C	.09	1	.09	1.52	.220
B * C	.00	1	.00	.00	.993
A * B * C	.01	1	.01	.19	.666
Error	7.61	123	.06		
<b>Total</b>	<b>1463.07</b>	<b>131</b>			

\* P<.05

With the results of three-way analysis of variance, in-service elementary and science teachers' attitudes toward science teaching were examined whether there were significant mean differences between genders, education levels of teachers, and science teaching method course taken or not.

When we look at the mean difference between male and female in-service elementary and science teachers, the attitudes of male teachers toward science teaching is higher than those of female teachers. This difference is significant with a F value of 6.961 and  $p < .05$ . Like attitudes toward science, attitudes toward science teaching has significant mean difference that the teachers who have a four-year college degree have higher mean differences than those teachers who have a two or three-year college degree ( $F_{(1, 123)} = 3.977, p < .05$ ). On the other hand, there is no significant mean difference on the attitudes of teachers who took science teaching method course or not during college years although the attitudinal mean of the teachers toward science teaching who have a four-year college degree is higher. Consequently, null hypotheses for gender and education levels on attitudes toward science teaching are rejected but for science teaching method courses not rejected.

## DISCUSSION

After analyzing data, the findings show that Turkish in-service elementary and science teachers have positive attitudes toward science as well as

science teaching in overall. This finding would be a satisfactory result to meet one of the qualities of teachers who teaches science in primary schools (Table 1). While the attitudinal mean of science is slightly higher than those of science teaching, they are very close that in-service elementary and science teachers conceive attitudes toward science and science teaching at the same degree. The similar results were also found in previous studies which used STAS and STAS-II conducted by Gabel (1980), Bonnstetter (1984), Ateaq (1995), and Turkmen (1999, and 2002b).

Like previous studies conducted in Turkish context, it is important to know for teacher preparation in science and elementary teaching areas that pre-service and in-service elementary and science teachers show positive attitudes toward science as well as science teaching. Another important point is that as reported in Pigge & Marso's study (1997), the science and elementary science teachers with positive attitudes toward science and science teaching should influence students' attitudes to positive direction and also this influence could increase students' achievement in science courses.

In fact, the major theme of this study is related to attitude toward science and science teaching but the sub-scales of STAS-II in science area mostly deal with the main tenets of the nature of science and some aspects of science, technology and society. Therefore the results of sub-scales of STAS-II give more insight into how pre and in-service elementary and science teachers perceive science and science teaching. At this point, the findings of this study and previous studies in Turkish context would be important.

The first sub-scale of STAS-II covers whether scientific concepts, principles, theories and laws are subject to change or not. Besides, this is one of the most important tenets of the nature of science (Lederman, 1986) that scientific findings are not 100% certain and unchangeable truths. In this study, in-service elementary and science teachers have opposite attitude toward this part of sub-scales of 1-A and 1-B (Table 2 and 7). In one sense, they strongly accept that the theories and laws of science are approximation and they are subject to change. On the other hand, they also give credit that scientific theories and laws are certain truths and not subject to change. It is difficult to say what reason lies behind this result. However, one reasonable explanation of this result would be that during almost entire school years, students were generally taught the concept of scientific law in any context as unchangeable and certain things. A study conducted by Turkmen (2004) support this idea that pre-service elementary teachers thought scientific theories as not proved but laws as proved. Also, current Turkish high school biology text book printed by the National Ministry of Education states that scientific laws are proved certain truths (Ministry Of National Education, 2004, see

p.1). This wrong representation can be the main reason behind the misunderstanding of scientific theories and laws by students and teachers. Even in two previous studies conducted in Turkish context, the same results could be seen which would not be a coincidence (Table 7).

The sub-scales of 2-A and B of STAS-II deal with the basis of scientific explanation or how we get the scientific explanation. Like the two previous studies, this study indicates that in-service elementary and science teachers consider the basis of scientific explanation as observation and experimentation as well as authority due to observed negative attitudes toward subscale 2-B (Table 2 and 7). This result could be interpreted as in and pre-service science and elementary teachers in Turkish context could not exactly understand the means of acquiring scientific knowledge by scientists as observation and experimentation or authority.

Another problematic area in sub-scales of STAS-II is 4-A and B that participants could not differentiate the purpose of science which is idea generating activity and explaining natural phenomena from technology generating activity and serving human kind. They strongly accept both as the purposes of science. This finding shows that in and pre-service Turkish science and elementary teachers consider the purpose of science as to explain natural phenomena and serve human kinds at the same time (Table 2 and 7). Bonnstetter (1984) found the similar results for US exemplary science teachers according to the sub-scales of STAS in 1-A and B as well as 4-A and B. From this point, it could be said that conceiving some important tenets of the nature of science among teachers shows some similarities in Turkish and US contexts.

Overall in-service elementary and science teachers' attitudes toward science teaching are positive. However, in-service elementary and science teachers' attitudes indicate some dilemmas, like previous studies conducted in Turkish context. In-service Turkish elementary and science teachers like to teach certain facts in science and also they see the place of a teacher in science courses as a facilitator (student centered) as well as authoritarian teacher (teacher centered). This finding should be important in science and elementary teacher education programs because these programs put more emphasis on student centered methods than other methods but to change in-service and pre-service elementary and science teachers attitude toward student centered science teaching do not seem to be easy as expected (Table 3 and 7). The similar result could be thought about the attitudes toward science for some basic tenets of the nature of science.

The sample size of this study is only limited for a province of Turkey but one of the previous study (Turkmen, 1999) covered all of Turkish pre-service science teachers and its sample size was 632. On the other hand, when the means of sub-scales of three studies in Turkish context are



compared, the Pearson correlation co-efficient for subscales (around .96) are quite high. Therefore, this limited sample size of this study would not be really a problem. Additionally, these findings would support the validity of STAS-II in Turkish context.

When the previous findings of STAS-II in Turkish context, the means of sub-scales of STAS-II seem to be very close. It could not be thought it is a coincidence. The reason should be that pre-service, in-service science and elementary teachers almost have the same attitudes toward science and science teaching. However, the present study is limited only a province of Turkey covering in-service elementary and science teachers, the outcomes of this study indicates similarities with the previous ones. The means of subscales could be seen on the following tables.

**Table 7. Average Item Score Means for sub-scales of STAS-II related to science by studies in Turkish context.**

Sub-Scales	1A	1B	2A	2B	3A	3B	4A	4B	5A	5B
Y1999	3.95	2.87	3.92	2.70	3.97	4.20	3.96	1.95	3.64	3.24
Y2002	3.87	2.90	3.91	2.60	3.83	4.08	3.72	2.04	3.78	3.27
Current	3.90	2.74	3.74	2.57	3.93	3.94	3.99	1.99	3.66	3.25

**Table 8. Average Item Score Means for sub-scales of STAS-II related to science teaching in Turkish context.**

Sub-Scales	6A	6B	7A	7B	8A	8B
Y1999	3.85	4.30	3.77	1.81	3.87	1.93
Y2002	3.30	3.85	3.88	1.78	3.76	1.81
Current	3.65	4.14	3.71	2.08	4.20	2.23

Attitudes toward science show only one significant difference which is the education levels of teachers but attitudes toward science teaching show two significant differences which are the education level of teachers and the gender of teachers (Table 5 and 6). While the education level of in-service science and pre-service elementary and science teachers gets higher, their attitudes toward science and science teaching becomes more positive which is justified by significant mean differences in three-way ANOVA results (Table 4, 5 and 6). This finding could support the idea that the education levels of teachers positively influence attitudes toward science and science teaching. In addition, it is found that male teachers' attitudes toward science teaching are significantly higher than those of female teachers' attitudes.

The studies of Simpson and Oliver (1985) and Weinburg (2000) report that male students have more positive attitudes toward science than

female students in middle and high school level. However, like previous studies conducted by Turkmen (1999 and 2002b), this study could not find any significant differences on the attitudes toward science between genders. The reason would be that students in middle and high school level have not yet chosen their major study areas but college level students and pre-service teachers have already preferred their major study areas as science related or not. Therefore, college students or in-service and pre-service teachers working in a science area could not indicate significant mean difference on attitudes toward science teaching based on their gender.

Attitudes as psychological domain would be influenced from many factors during life time. In this study, only education levels of teachers have meaningful effect on the attitudes toward science as well as science teaching. On the other hand, it does not mean the other socio-economical factors do not have any effect on the attitudes. Many factors could shape our attitudes (to) about a certain domain, such as science and science teaching. However, finding the degree of their effects is not easy.

#### **IMPLICATION FOR EDUCATION AND SUGGESTIONS**

Although in-service Turkish elementary and science teachers have positive attitudes toward science and science teaching, the teachers who have mostly a two-year college education degree did not show positive attitudes as much as those teachers who have a four-year college degree. For those teachers having a two-year college degree, there might be some special seminars related to the nature of science. Especially these planned seminars as in-service education might expand to all in-service elementary and science teachers for certain points such as what science is, the purpose of science, and the difference between science and technology. After finding similar results on pre-service science and elementary teachers; science educators, science teaching textbook writers and curriculum developers for science and elementary teacher education would emphasize these points more (than ever).

In this study and two previous studies carried out by Turkmen, (1999, 2002), STAS-II has been employed. The results of the three studies are compared according to the sub-scales of STAS-II. As shown in Table 7 and 8, the means of sub-scales are close to each other. This result could not be a coincidence that in-service and pre-service elementary and science Turkish teachers have similar attitudes toward science and science teaching. If another study is conducted by another researcher in Turkey, the results would be expected to be similar to previous ones. For example, a study conducted by Bonnstetter (1984) in US exemplary science teachers showed almost similar results. Therefore, it could be inferred that elementary teacher and teacher candidates might have some problems to

conceive the basic and important tenets of the nature of science. In long term, science teachers or educators should put extra emphasis on these points mentioned above. It should not be forgotten that attitudes of teachers and students toward science and science teaching do not change easily especially in a short time period. However, almost from the first grade to college level, gaining positive attitudes toward science would be one of the central purposes of science education. This is true not only for some certain countries but also the other countries due to found common problems in the literature.

Future studies should emphasize the longitudinal aspects of attitudes toward science as well as science teaching and also find out the extent of the effects of socio-economical factors.

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