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Turkish pre-service elementary science teachers' scientific literacy level and attitudes toward science

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ABSTRACT: In order to educate elementary students scientifically literate as expected in the science curricula in many countries around the world, science teachers need to be equipped with the diverse aspects of scientific literacy. This study investigates whether pre-service elementary science teachers at universities in Turkey have a satisfactory level of scientific literacy, and how the level of scientific literacy is affected by different variables, such as attitude toward science, gender, year in university, and education level of parents. The domains of scientific literacy for this study are scientific content knowledge (SCK), nature of science (NOS), and the nature of technology (NOT). The data were collected with the Test of Basic Scientific Literacy (TBSL) and the Scientific Attitude Inventory (SAI-II). The sample consisted of 667 first-year and 405 fourth year pre-service teachers from 10 education faculties in all regional areas in Turkey. The results indicated that pre-service teachers have adequate levels of scientific literacy regardless their gender and year in university. The comparisons illustrated that female students score higher than males, and 4th year students score higher than 1st year students in the TBSL.

KEY WORDS: scientific literacy, science teacher, nature of science, attitude

INTRODUCTION

Scientific literacy has long been a motive for science education in many countries (e.g. Abd-El-Khalick, Bell, & Lederman, 1998; American Association for the Advancement of Science, 2001; Ministry of National Education in Republic of Turkey, 2006; Ministry of Education in Taiwan, 2001; National Research Council, 1998). The term 'scientific literacy' refers to understanding of science to contribute to public debate of socio-scientific issues and to make informed decisions on these issues, as well as the appreciation of processes, values and ethics related to science

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(Dawson & Venville, 2009; MoNE, 2006). Science teachers are the major input in the achievement of the scientific literacy at all levels of education due to the important role of science teachers in preparing future scientifically literate citizens (Chin, 2005). This study, therefore, attempts to investigate whether pre-service elementary science teachers at universities in Turkey have a satisfactory level of scientific literacy, and how the level of scientific literacy is affected by different variables, such as attitude toward science, gender, year in the university, and education level of parents.

Describing Scientific Literacy

There have been several research studies with the aim of investigating and describing the aspects of scientific literacy. The attempts to define scientific literacy involve efforts to relate school science to daily life of the pupils, to prepare pupils for decision-making in democratic societies, to raise awareness for issues related to environment, technology, and human life, as well as to promote insight into the nature of science (Driver, Leach, Millar, & Scott, 1996). Therefore, scientific literacy encompasses abilities ranging from appreciation and understanding the impact of science and technology on everyday life and promotion of positive attitudes to the capacity to use scientific knowledge, to identify questions and to draw evidence-based conclusions (OECD, 2003; MoNE, 2006).

Perspectives which value students' scientific knowledge and ways of using this knowledge as citizens state that scientific literacy can be defined as "knowledge and understanding of scientific concepts and processes required for personal decision-making, participation in civic and cultural affairs, and economic productivity" (NRC, 1996, p. 22). Although it is not fully contradictory, there are also perspectives which consider the relevant social context and claim that the modes of interaction and socio-historical contexts brought into play in the construction of scientific literacy (Roth & Lee, 2002). As a result, there is a wide acceptance in science education community that being scientifically literate is a requirement in order to function responsibly and effectively within a society in a rapidly changing world. Therefore, an increasing number of science educators assert that the goal of science education should be directed to enhance responsible citizenry based on scientific literacy (Kolsto, 2000; Holbrook & Rannikmae, 2007).

To sum up, scientific literacy is the collective abilities and skills to function as a responsible citizen in scientifically and technologically dominated society. This definition not only involves the knowledge and understanding of science but also the combination of attitudes, values, and reasoning related to science-technology and their impact on society.

Scientific Literacy as a Curriculum Goal

The UNESCO Conference, Science for the Twenty-First Century: A New Commitment, in 1990 discussed that science education should be related to "a world community of scientifically and technologically literate citizens" (UNESCO, 1999; Layton, Jenkins, & Donnelly, 1994). A majority of national reports and curricula are dedicated to achieve this goal. For example, in the US, National Research Council (1998) stated that for students to adapt in a rapidly changing world and technological advancements, science educators need to assist them with understanding science and technology. While our daily life becomes more and more nested with science and technology, children would need education to prepare them "to think critically, synthesize information accurately, and solve problems creatively" (NRC, 1998, p.4). In the book Every Child a Scientist: Achieving Scientific Literacy for all, it is reported that most high school graduates are not able to use scientific knowledge accurately in their lives. Therefore, in the US, through National Science Education Standards, the school programs were improved to educate students as scientifically literate.

In the UK, Twenty First Century Science Project (2009) was initiated to include a course with a scientific literacy emphasis. In the project documents, the skills of a person who has an acceptable level of scientific literacy are listed such that;

> "[a person who is scientifically literate] appreciates and understands the impact of science and technology on everyday life; takes informed personal decisions about things that involve science; reads and understands the essential points of media reports about matters that involve science; reflects critically on the information included in, and (often more important) omitted from, such reports; and take part confidently in discussions with others about issues involving science"

Considering scientific literacy, there is another important example in the Australian curriculum, which is being developed progressively in 2011. In the curriculum, the rationale for scientific literacy was provided and the curriculum makers suggest the following abilities for a scientifically literate person:

"the ability to use scientific knowledge, understanding, and inquiry skills to identify questions, acquire new knowledge, explain science phenomena, solve problems and draw evidence-based conclusions in making sense of the world, and to recognize how understandings of the nature, development, use and influence of science help us make responsible decisions and shape our interpretations of information" (ACARA, 2011).

In Turkey, a major science curriculum reform was initiated in 2004. The main vision of the science and technology curriculum was stated as educating all students –whatever their personal differences are- as

scientifically and technologically literate (MoNE, 2006). This idea recognizes the need for knowledge of science concepts, appreciation of nature of science, and reasoning in dealing with the issues of scientifically and technologically impacted society. By renewed science education curriculum in 2013, the goal has been re-emphasized including the importance of inquiry and covering also primary science education (MoNE, 2013).

In 2004 and 2013, elementary science and technology curriculum in Turkey states the definition of scientific literacy by means of a range of knowledge and skills including the understanding of the effect of science and technology in our daily life, the acquisition of positive attitudes toward the use of scientific knowledge, asking scientific questions, and making inferences based on evidences. To achieve these goals embedded in the definition of scientific literacy, science course content is divided into seven learning areas: Physical Processes; Life and Living Beings; Matter and Change; The Earth and the Universe; which are all corresponding to Science Content Knowledge (SCK); Science Process Skills (SPS); Science-Technology-Society-Environment (STSE), and, Attitudes and Values (AV) (Tasar & Atasoy, 2006, MoNE, 2004; 2013).

Factors in relation with Scientific Literacy

The research about factors that contribute to the concept of scientific literacy yields a range of results. For example, the study by Nwagbo (2006) investigating the relationships among achievement, attitude and two teaching methods for different levels of scientific literacy for 147 undergraduate biology students reached several conclusions such that the guided inquiry method is significantly better than the expository method in enhancing cognitive achievement for students of all levels of scientific literacy, and students of different levels of scientific literacy show positive attitude to biology (Nwagbo, 2006). The relationship among science-technology and society, scientific literacy, and achievement in biology was also investigated in another study which is conducted as a quasi-experimental design with a sample of 246 students from secondary schools (Mbajiorgu & Ali, 2003). The results of the research indicated that there is no relationship between scientific literacy and achievement in biology.

Regarding students' scientific literacy, Bybee and McCrae (2011) claim that attitudes toward science play an essential role. The scope of attitudes covers cognitions, feelings, and inclinations toward action. These components influence students' continuous interest toward science and science-related issues (Bybee & McCrae, 2011). In PISA 2006 assessment, scientific literacy was the major assessment domain and the definition of scientific literacy in this assessment included the aspects of individuals' attitudes toward science as well (OECD,2003). However,

further attempts to investigate scientific literacy paid little attention on attitudes as a component of scientific literacy.

Considering the abovementioned research, there are several other variables to investigate in terms of their relation to scientific literacy such as the interaction of teaching and learning strategies, achievement, and attitudes. Additionally, there is lack of information about how other dimensions and factors such as attitude toward science, gender, grade level, and education level of parents are related to scientific literacy. Hence, this study was conducted to find out these possible interactions.

Significance of the study

In Turkey, scientific and technological literacy permeates the revised science and technology education program for elementary grades. After the validation of elementary science and technology curriculum in 2004, Bacanak and Gökdere (2009) conducted a study to investigate the level of scientific literacy among pre-service teachers. In the study, two scientific literacy tests were used to examine the level of scientific literacy for pre-service science teachers. Comparing the final results of the study with another research focusing on primary and secondary level students' scientific literacy (Manhart, 1997), researchers argued that the results were quite interesting since pre-service science teachers, who are expected to raise the level of science literacy in future generations, had closer and even lower scientific literacy levels than elementary students (Bacanak & Gökdere, 2009). The case being made is that if pre-service teachers are equipped with the diverse aspects of scientific literacy, they can more easily adapt the science content to the requirements of curriculum to educate their future elementary students as scientifically literate. On the other hand, without knowing their level of scientific literacy, it will be less realistic to give doctrines to help pre-service science teachers adapt scientific literacy in their future science classrooms. Hence, there is need to assess the level of scientific literacy of future elementary science teachers in order to provide them with appropriate teacher education programs. Therefore, this study provides an indication of the level of scientific literacy of pre-service science teachers as an attempt to inform policy makers and educational researchers about how realistic they are in their perception related to the pre-service science teachers' skills to achieve the goals of science curriculum. When shaping the teacher education programs according to the goals of the science curriculum for elementary grades, the need for evidence-based research becomes crucial. Since this study provides a comparison of scientific literacy levels between first and fourth-year pre-service teachers in relation with other variables such as attitude toward science, gender, and education level of parents, the evidence obtained will inform science teacher educators about

how effective the teacher education programs are bringing in the skills associated with scientific literacy.

In the present study, pre-service elementary science teachers were chosen as population because of two main reasons: (1) they took science courses before and after they enter into undergraduate programs so they were expected to achieve a high level of understanding of science and scientific literacy, and (2) they will become science teachers in elementary schools so their understanding and knowledge of science will be reflected in their future classes. Freshman and senior students were selected for comparing their levels of scientific literacy and attitudes toward science upon entering the university and before graduation.

RESEARCH QUESTIONS

The effectiveness of science education highly depends on the efficacy of teachers. Therefore, to achieve a high level of scientific literacy at all levels of education, the teachers should be well trained in all dimensions of scientific literacy. This study, therefore, focused on the scientific literacy of pre-service elementary science teachers in relation to the factors such as attitude toward science, year in the university, grade level, and education level of parents.

1. What is the scientific literacy level of pre-service elementary science teachers in overall and in the sub-dimensions of scientific literacy including understanding of the nature of science, understanding of the nature of technology, and basic science content knowledge?

2. What are the pre-service elementary science teachers' attitudes toward science?

3. Are there any differences in scientific literacy levels and attitudes of pre-service elementary science teachers toward science in terms of gender, year in university, and education level of parents?

4. Is there a relationship between attitudes toward science and scientific literacy level of pre-service elementary science teachers?

METHODOLOGY

In the methodology section, the sampling procedure of the participants, the data collection and analysis procedure were described.

Sampling Procedure

Data were collected from the freshman and senior students who are enrolled in elementary science education programs at 10 public

universities, which were selected from all regional areas in Turkey. Students who are enrolled in undergraduate teacher education programs of the universities in Turkey are selected and placed by a central examination. In Turkey, faculties of education at universities are responsible for offering teacher education programs. As part of their four-year university preparation program, prospective science teachers learn about natural and applied sciences, such as physics, chemistry, biology, etc., and domain-specific pedagogical knowledge. Anyone, who completes a four-year elementary science teacher education undergraduate program, can be a science teacher in public or private elementary schools.

The sample of the present study consists of 1072 pre-service elementary science teachers. The characteristics of the sample can be seen in Table 1.

Table 1. The characteristics of the sample

Variable	Categories	n	%
Gender	Male	655	61.1
	Female	417	38.9
Year in the university	First year	667	61.4
	Fourth year	405	37.8
Mother's education level	Illiterate	112	10.5
	Primary	561	52.5
	Secondary	130	12.2
	High School	181	16.9
	University	81	7.6
	Master	2	.2
	PhD	2	.2
Father's education level	Illiterate	30	2.8
	Primary	312	29.2
	Secondary	140	13.1
	High School	316	29.6
	University	261	24.4
	Master	8	.8
	Ph.D.	2	.1

There are some demographic variables that would be significant for this study. For example, females represented more in the sample (61.1%) and males represented only 38.9% of the participants. This representation of genders in the sample reflects the preference of teaching programs by different genders in Turkey. Another variable is related to the number of students in their first year(61.4%) and in their last year (37.8%) in science teaching programs. The number of last year students is almost half of the first year students in the sample because most of the students in their last year do not attend classes since they are in preparation for a nation-wide exam for employment in public schools after graduation. Besides, there is a big difference between mothers' and fathers' education level. Almost

10% of students' mothers 3% of students' fathers do not have any formal education. These percentages validate the statistics showing that a large percentage of students enrolled in teaching programs are coming from families with middle or lower level of social-economic status.

Data Collection Instruments

Laugksch and Spargo (1996) developed the Test of Basic Scientific Literacy (TBSL) to examine the scientific literacy levels of university students. TBSL is a 110 item-test, which is prepared based on the scientific literacy definition in the document by Science for All Americans (AAAS, 1990) and Miller's (1983) scientific literacy categories. The dimensions of scientific literacy in the TBSL are nature of science (22 items), science content knowledge (72 items), and the impact of science and technology on society (16 items) (Laugksch & Spargo, 1996). Chin (2005) administered this scale to the freshman students who are enrolled in elementary studies (n=141) and science education (n=138) departments in Taiwan. The results of the study showed that first year pre-service teachers have adequate levels of scientific literacy. Similarly, in this study, Turkish adaptation of the instrument was used to determine the level of scientific literacy for pre-service science teachers.

The subscales in the TBSL are science content knowledge (SCK), nature of science (NOS), and effect of the nature of technology including technology and society, design and systems, and issues in technology (NOT). Science content covers three sub-categories: (1) physical science, which includes information about the universe of matter, energy transformation, motion, forces of nature, the earth, and forces that shape the earth; (2) health science, which includes information about human identity, human development, basic functions, learning, physical health, and mental health; and (3) life science, which includes information about diversity of life, heredity, cells, interdependence of life, flow of matter and energy, evolution of life. The test includes totally 110 statements related to the dimensions of scientific literacy.

TBSL was translated into Turkish and validated before the study. The details of the validation process were reported in PhD dissertation by Huyuguzel-Cavas (2009). In order to examine the internal consistency of the TBSL scale in this study, the Cronbach alpha (α) values were calculated for the subscales and the whole test. The Cronbach alpha value for the whole test is .92; for NOS, NOT and SCK are .60, .60 and .91 respectively. Earlier studies reported similar reliability values for the TBSL. For example, Chin (2002) used Chinese version of the TBSL and calculated its reliability between .62 and .89 for each scale, and a value of .93 for the whole test.

The participants' attitude toward science was measured by the Scientific Attitude Inventory (SAI -II) (Moore & Foy, 1997). The SAI-II

is a five-point Likert-type instrument consisting of 40 items. Demirbas and Yagbasan (2006) translated and adapted the SAI-II into Turkish. The half of the items are positive statements (numbers with letter A) while the remaining half are negative (numbers with letter B). The scale has 6 sub-dimensions. Five of them are related to nature of science and scientists' ways of working, and 1 sub-dimension is related to science in general. The dimensions are presented in Table 2.

Table 2. The dimensions of the Scientific Attitude Inventory (SAI-II)

Number of Items	Content of the positions	Positive items	Negative items
6	The nature of scientific theories and laws	(4, 16, 34)	(11,15, 35)
6	The basis of scientific explanation and what science deals with	(10,19,33)	(2,7,26)
6	How to operate in a scientific manner	(17,18,25)	(3,5,32)
6	What science is and what science is devoted to	(20,21,28)	(9,24,31)
6	The role of science in society	(12,23,29)	(6,8,38)
10	The characteristics of a scientist	(1,27,30,36,40)	(13,14,22,37,39)

In the SAI-II, the possible highest score is 200 whereas the possible lowest is 40. Moore and Foy (1997) reported Cronbach Alpha reliability as .78 and Spearman-Brown reliability coefficient as .80. For the Turkish version of the SAI-II, Demirbas and Yagbasan (2006) reported the reliability as .76 by Cronbach Alpha, and as .84 by Spearman-Brown. The Cronbach Alpha reliability coefficient of the instrument was found to be .72 for the current study.

Data Collection and Analysis Procedure

In the present study, the instruments were administered to pre-service elementary science teachers. Participants completed the TBSL and SAI-II as well as demographic information in 45 minutes. The universities were randomly chosen from seven regional areas in Turkey: Aegean region, Marmara region, Black Sea region, Mediterranean Sea region, East Anatolia region, South-eastern Anatolia region, and Central Anatolia

region. All responses were entered in SPSS-20 package program and the descriptive statistics and inferential analyses were generated.

RESULTS

To investigate the research questions given, descriptive statistics were reported and inferential analyses were conducted. In this section, the results of the study were presented.

Pre-service Elementary Science Teachers' Scientific Literacy Levels and Attitudes toward Science

Scientific literacy level of pre-service elementary science teachers with different dimensions including understanding of the nature of science (NOS), understanding of the nature of technology (NOT), basic science content knowledge (SCK) were assessed through the TBSL and their attitudes toward science was measured by the SAI-II. The participants' mean scores regarding selected variables were presented according to gender and grade level in Table 3.

Table 3. Pre-service teachers' mean scores of TBSL and attitudes and standard deviations regarding gender and grade level

		Gender					
		Male		Female		All	
Year in university		Mean	SD	Mean	SD	Mean	SD
1	NOS	12.28	2.96	12.65	2.97	12.42	2.97
(N= 667)	NOT	9.53	2.38	9.45	2.54	9.50	2.43
	SCK	46.84	10.66	46.20	11.02	46.61	10.79
	TBSL	68.57	14.41	68.31	14.72	68.47	14.51
	Attitude	3.39	.31	3.33	.43	3.37	.32
4	NOS	12.82	2.99	10.45	4.34	13.18	3.21
(N= 405)	NOT	10.14	2.49	9.68	2.41	9.94	2.44
	SCK	52.49	11.14	48.23	11.40	50.62	11.44
	TBSL	76.11	14.71	70.84	15.42	73.79	15.23
	Attitude	3.43	.36	3.34	.35	3.39	.35

Analysis of participants' responses to the TBSL indicated that pre-service elementary science teachers (PST) could be considered as scientifically literate in their first year (M= 68.47) and in their fourth year (M= 73.79) since they achieved more than or equal to 68 out of 110 according to Laugksch and Spargo (1996) (Table 3). When the dimensions of scientific literacy were considered, 1st year PSTs did not have an adequate level of understanding NOS (M=12.42, SD=2.97) but at 4th year they had a certain level of understanding NOS (M=13.18, SD=3.21). Considering the

understanding of nature of technology (NOT), both groups nearly placed at threshold point (1st year M=9.50, SD=2.43; 4th year M=9.94, SD=2.44). In other words, both groups had certain level of understanding NOT over 50%. Both 1st and 4th year PSTs seemed to have an adequate level of science content knowledge (SCK) since their mean scores were higher than 72 which is threshold score for this dimension of the TBSL. Related to sub-dimensions of SCK, 4th year students were more successful than first year students in all areas including physical science, life science and health science.

Regarding the attitudes of the participants, it was found that pre-service science teachers' attitudes toward science were at average level. Both of the groups had similar attitudes toward science (M=3.37 for the first year students; M=3.39 for the fourth year students).

When gender issues were taken into account, it seems that females and males have similar scores from all variables in their first year. However, it is interesting that fourth year students' scores differed according to their gender, in favour of females. In order to analyse differences, two-way ANOVA was utilized. The results of this analysis are given in Table 4.

Table 4. The results of the ANOVA

Variables	Two-Way ANOVA		Source		
	F	p	Gender p	Year p	Gender*Year p
NOS	2.26	.08	.474	.001*	.010*
NOT	.931	.425	.085	.007*	.227
SCK	1.32	.266	.001*	.000*	.011*
Overall (TBSL)	.82	.48	.003*	.000*	.008*
Attitude toward science	1.97	.12	.000*	.279	.532

*p < 0.05

Table 4 shows the comparison of the selected variables in terms of gender and year in the university. Regarding gender, significant differences were found in the SCK, TBSL and Attitude toward Science scores in favour of females. Females' scores of the SCK, TBSL and Attitude toward Science are 48.80, 71.18 and 136.19; and males' scores are 47.06, 69.30, and 133.34 respectively. Although these differences were statistically significant, the effect sizes were very small. The eta squared for the SCK, TBSL and Attitude toward Science were .011, .008 and .012 respectively. When years in university were compared, all p values, except attitude toward science, were lower than .05. This means that these results are significant for the TBSL (p = .000), SCK (p = 0.000), NOS (p = 0.001), and NOT *(p=0.007*). Fourth year students possessed higher scores than

first year students in all subscales of the TBSL, total TBSL and the Attitude toward Science. However, the effect sizes for these variables were very small. There was also a significant gender and year interaction effect for the NOS, SCK and TBSL.

Scientific literacy levels and attitudes of pre-service science teachers toward science in terms of education level of parents

A one-way between groups analysis of variance was conducted to explore the impact of mother and father educational level on scientific literacy and attitudes toward science scores. Subjects were divided into five groups according to mother and father education level (Group 1: not literate; Group 2: primary school graduate- 1 to 5; Group 3: elementary school graduate- 6 to 8; Group 4: high school graduate- 9-11; Group 5: university/college graduate). The results are presented in Table 5.

Table 5. Descriptive statistics of participants' scientific literacy and attitude toward science level with respect to mother and father educational level

Educational Level	TBSL				Attitude toward Science			
	Mother		Father		Mother		Father	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Illiterate	69.65	14.87	73.77	13.43	136,56	12,56	138,40	14,05
Primary	70.39	15.10	70.59	15.15	134,50	13,63	134,16	13,41
Secondary	67.67	15.15	68.08	13.49	134,50	13,64	137,16	12.13
High School	72.34	14.99	71.06	15.12	136.31	12.96	134.59	13.49
University	72.87	13.21	70.69	15.58	134.99	13.13	135.32	13.62

Table 6. Post-hoc comparisons using the LSD

Variable		Source	*df*	Mean Square	*F*	p
Mother	TBSL	Between Groups	4	552.58	2.48	.04*
		Within Groups	1059	222.76		
		Total	1063			
	Attitude toward Science	Between Groups	4	187.83	1.05	.38
		Within Groups	1059	178.913		
		Total	1063			
Father	TBSL	Between Groups	4	312.98	1.39	.23
		Within Groups	1055	225.09		
		Total	1059			
	Attitude toward Science	Between Groups	4	322.15	1.81	.13
		Within Groups	1055	178.19		
		Total	1059			

Since the number of mothers and fathers having BA and PhD degrees are very few, these variables were extracted from data in order to be able to

make post-hoc comparisons. Post-hoc comparisons using the LSD were conducted to illustrate whether there were meaningful differences between groups. These results are shown in Table 6.

In terms of mother education level, there was statistically significant difference at the p<.05 level in the TBSL scores for the five educational level groups [F(4, 1059)=2.48, p=.04]. Post-hoc comparisons showed that students whose mothers were graduated from secondary school had lower TBSL scores than other students whose mothers were graduated from high school and university with a very small effect size (eta squared<.01). Interestingly, having a non-literate and primary school graduated mother did not lay significant differences with other levels. Therefore, based on this result, it would not be correct to say that mother education level has a significant effect on pre-service science teachers' scientific literacy at university level. However, students' attitudes toward science scores did not differ regarding mother education level. In terms of father education level, there was no statistically significant difference at the p<.05 level in the TBSL and attitudes scores for the five educational level groups.

Relationship between attitude toward science and scientific literacy level of pre-service science teachers

The relationship between attitude toward science (as measured by the SAI-II) and basic scientific literacy (as measured by the TBSL) through years in teacher education programs (1st and 4th years) was investigated using Pearson product-moment correlation coefficient. Table 7 summarizes the statistics related to the correlation.

Table 7. Pearson product-moment correlations between measures of basic scientific literacy and attitude toward science

Correlations			ATTITUDE	TBSL
First Year (N=667)	ATTITUDE	Pearson Correlation	1	.270**
		Sig. (2-tailed)		.000
	TBSL	Pearson Correlation	.270**	1
		Sig. (2-tailed)	.000	
Fourth Year (N=405)	ATTITUDE	Pearson Correlation	1	.165**
		Sig. (2-tailed)		.001
	TBSL	Pearson Correlation	.165**	1
		Sig. (2-tailed)	.001	

**Correlation is significant at the .01 level (2-tailed).

Preliminary analyses were performed to ensure no violation of normality, linearity and homoscedasticity. Results showed that there was a weak positive correlation between the two variables in the first year (r=.27, n=667, p(.000)<.01) and in the fourth year (r=.16, n=405, p(.001)<.01),

with positive attitude toward science associated with high levels of scientific literacy (Table 7).

DISCUSSION

Research related to instruction shows that teacher is one of the most important components in the learning process. Therefore, lots of research has been dedicated to understand the teachers' knowledge, attitude, beliefs, skills, etc. The main reason underlying these intense investigations is the belief that teachers' knowledge, beliefs and actions would be important in shaping future generations. This study is also based on this belief that the science teachers' scientific literacy is important in the achievement of scientific literacy all levels of education (Chin, 2005). Besides, we hold another perspective in this study related to having an adequate level of scientific literacy. That is, we believe that having a high level of scientific literacy is a necessity for a science teacher because of its role in teachers' intrinsic motivation in science teaching. A science teacher, who has the knowledge and abilities associated with scientific literacy would appreciate the nature and role of science in general and in his/her society, and most importantly would be attentive in determining the quality of science education in many ways. Therefore, we care about both pre- and in-service science teachers' scientific literacy not only because this will be reflected in students' knowledge and abilities but also in science teachers' professional identity and quality of teaching.

Therefore, in this study, pre-service science teachers' basic scientific literacy levels and their attitudes toward science were investigated using some demographic factors such as gender, year in the university, and education level of parents. The further analysis was also implemented on the relationship between PSTs' scientific literacy levels and their attitudes toward science. When shaping the teacher education programs according to the goals of the science curriculum applied in the elementary grades, the need for evidence-based research becomes crucial. Since this study provides a comparison of scientific literacy levels between first and fourth-year pre-service teachers in relation with other variables such as gender, parent educational status, etc., the evidence obtained will inform researchers how effective the teacher education programs are in saving the skills associated with scientific literacy.

Results of the present study indicated that pre-service elementary science teachers have an adequate level of scientific literacy. The level is significantly higher in 4^{th} year students for all sub-dimensions of scientific literacy (SL). This significance can be interpreted as the positive impact of teacher education programs in terms of raising PSTs' the SL level especially in their science content knowledge and appreciation of nature of science and technology. There are some courses that might be effective

in this improvement in undergraduate teaching programs. For example, the courses that put emphasis on the interrelationships between science, technology and society; nature of science; history and philosophy of science might be helpful in raising pre-service science teachers' awareness towards the role of science in general. Moreover, the skills related to science and science teaching are highlighted continuously in both science courses and science teaching methods, laboratory applications in science and practice in science teaching.

Based on the gender and years in the university interaction effect results, being a senior female PST makes a significant difference in terms of understanding of NOS and comprehension of basic science concepts. This result is worthy because it can be interpreted that, in opposite to the general trend, female PSTs are more involved in science in general, with the exception of understanding of nature of technology, and show higher levels of appreciation of what science is.

Interestingly, the mothers' education level was found to be a significant factor in determining SL. Our expectation was to find a significant difference in terms of both parents' education level but we found that fathers' education does not make any difference. This result can be interpreted that usually in traditional families, mothers are responsible to look after the children and they are the first who take care of children's education. Although, in this century, especially in big cities, both parents have to work out of home, and have a word on children's education, still in small cities, the traditional families are common. However, we should interpret this result with a caution since we did not ask PSTs who were responsible from or more interested in their education in their families or whether they have traditional family orientation.

Although previous studies indicated a positive correlation between attitude toward science and SL (e.g. Bybee & McCrae, 2011), in this study, this correlation was very weak. The possible explanation for this result is that PSTs have a certain level of background of science in their high school years, and dedicated to pursue a career in a science related field, and thus have a certain level of attitude toward science already before attending to a university. For that reason, university education does not create a jump or a significant difference in their general attitudes, although they improve their SL levels during university education.

As we move forward, regarding the expanding definition of scientific literacy, more time should be devoted to think about what knowledge and skills we would like our future citizens to develop and answer the following questions: What are the key ideas that should be focused on in science education? How can we support students in building the skills, character and values that help them to make decisions as scientifically literate citizens? How can we improve curriculum that bases on these needs and rebuilds itself in time? How should teachers be trained

to implement such a curriculum? Similar questions and more were directed by Choi et al. (2011) when they investigated the re-conceptualization of scientific literacy in South Korea for the 21st century and expanded the scope of scientific literacy to involve meta-cognition and self-direction.

In sum, the results of this study shed light on PSTs' scientific literacy level through their training in teacher education programs at universities. We believe that it is encouraging to see that the SL levels are found to be adequate before graduation. However, adequate level of scientific literacy does not ensure the translation of these adequate conceptions into practice in classrooms. Moreover, as Shelley (2009) states, "clearly, high-quality evidence is essential, but not sufficient, in making and justifying instructional decisions" (p. 447). Therefore, rather than considering this adequacy as enough, we should take this as an incidence to be motivated to improve teacher education programs continuously to meet the raising expectations of our century to educate citizens as scientifically literate and to support our future teachers in this line.

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