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Investigating the Relationship between Pre-Service Teachers' Scientific Literacy, Environmental Literacy and Life-Long Learning Tendency

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ABSTRACT: The study investigates the relationship between pre-service teachers' scientific literacy (SL) and their environmental literacy (EL). It also seeks significant differences in SL at different levels of a tendency towards life-long learning (LLT). With the world facing critical environmental problems, an interdisciplinary approach to teaching science and environmental issues may help students to regulate their learning, foster curiosity, and stimulate their motivation to learn, all of which would influence their overall SL. For this pre-service teachers' understanding of SL with respect to the environment is important. The scores from tests that assessed pre-service teachers' SL and EL were analysed for correlation. Findings from the study show that pre-service teachers' SL is correlated with four dimensions of EL, environmental knowledge, environmental attitudes, perception of environmental uses, and environmental concern. Analysis of the data also reveals a significant difference between the SL of participants in the first and third levels of four levels of LLT, while there is no significant difference between the SL of participants at other levels. Implications of the findings are discussed.

KEY WORDS: scientific literacy, environmental literacy, life-long learning tendency, pre-service teachers.

INTRODUCTION

As the world is faced with critical environmental problems, educational systems must produce environmentally literate citizens who care about the environment and have sufficient knowledge about environmental issues to behave responsibly (Tuncer et al., 2009). According to the recommendations of the American Association for the Advancement of Science (1989), SL (scientific literacy) requires a basic knowledge about the natural world and recognizing the functions of living things and their interactions between each other and their environment. Later definitions (Roberts, 2007; Holbrook & Rannikmae, 2009; Choi et al., 2011) put more stress on the values aspect as well as metacognition and thus see a

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scientifically literate society as one where people need social and environmental literacy as components of scientific literacy.

For more than a decade, climate change has been the concern of scientists and a topic of heated debates at local and national levels of Government (Houghton, et al., 2001; McCarthy, et al, 2001; Weingart, Engels, & Pansegrau, 2000; Whitmarsh, 2009). Human activities, such as the accumulation of waste, destruction of ecosystems, and depletion of natural resources, have had a profound effect on the environment (Cortese, 1999; Vitousek et al., 1997; WHO, 2005). These problems are discussed daily in communications media, pointing to the need for every individual to have scientific knowledge to understand, or participate in the discussions. SL becomes increasingly important as people make personal decisions and support or oppose public policy decisions that affect their lives (Bybee, 2008). SL also requires individuals to be life-long learners (CMEC, 1997; Millar, 2006; Norris & Phillips, 2003) and thus it is likely that the higher one's life-long learning tendency (LLT), the higher the attributes of SL.

This paper argues that both EL (environmental literacy) and LLT are related to SL. These relationships point to the need for an interdisciplinary approach to science teaching and learning, enlisting the cooperation of scientists, philosophers, psychologists, educators, and others. It is argued that creating a scientifically and environmentally literate citizenry requires such broad-based cooperation.

While earlier studies address the need to promote EL from the earliest grades to university and recognize the crucial role of well-informed teachers, researchers neglect the lack of sufficient cooperation by various disciplines that could otherwise contribute to the EL of teachers and students. Teacher education programs are a good place to end such neglect. Teachers need to be life-long learners who are scientifically and environmentally literate. In this respect, the paper seeks to draw attention to the necessity of an interdisciplinary approach to the SL and EL of pre-service teachers.

LITERATURE REVIEW

Scientific literacy (SL)

One of the goals of science education is a scientifically literate population. People nowadays receive more information and receive it faster than ever before. Not all of it is reliable, requiring people to make decisions about what they believe. Some of this information masquerades as science; hence every citizen has to make decisions about the reliability of scientific information concerning their health, the environment, and socio-scientific relations. Scientific literacy can play an important role in helping one to make suitable decisions.

The importance of preserving the environment has been emphasized increasingly since the 1970s. The Stockholm Declaration (1972) was the first international document to address the issue, and the Tbilisi Declaration (1977) emphasized the importance of science education in this respect. Today, SL encompassing the goals of science education is considered a necessity at all levels of education (Correia, Valle, Dazzani, & Infante-Malachias, 2010).

Miller (1983) suggested three dimensions of SL: an understanding of the norms and methods of science (i.e. the nature of science); an understanding of key scientific terms and concepts; and an understanding of the impact of science and technology on society. Although contemporary SL literature points out the need for additional dimensions beyond these three, Miller's framework has formed the basis of many recent studies (Cavas, et al., 2013; Özdem, et al., 2010; Roos, 2012; Rundgren et al., 2010).

Science Education in Turkey

The main goal of a 2004 reform of the science and technology curriculum in Turkey was to educate scientifically and technologically literate students (MoNE, 2006). The structure of the curriculum was based on Miller's three dimensions framework A revised science curriculum in 2013 reiterated these goals, while emphasizing the importance of inquiry and the inclusion of science education in primary schools (MoNE, 2013). The perspective of scientific literacy adopted by this study is based on Miller's framework. In this paper, SL is used to define an understanding of how science works including an interpretation of the reliability of scientific claims in decision making (Allchin, 2011).

Students in Turkey carry out simple science activities in preschool. From the 1^{st}-4^{th} grade in primary school, science topics are within a course of Life Sciences, organized to inform the students about basic science knowledge, such as living things, states of matter and change of state, seasons, rotation of Earth, sunrise and sunset, the environment and human impact on this, foods, the human body and also basic skills, such as observing, inferring and classifying (MoNE, 2009). The students study Science and Technology from the 4^{th} to 9^{th} grade. From the 9^{th} to 12^{th} grade students study Physics, Chemistry and Biology (MoNE, 2006).

While scientific and technological literacy is identified as the vision (MoNE, 2006), the scope in this study is narrowed by taking SL only into consideration and excluding attitudes and values related to technological literacy.

Components of SL

Foster and Shiel-Rolle (2011) presented a guide for developing short-term science camps to promote scientific literacy. They used pre- and post-knowledge assessment instruments, as well as student self-evaluation to determine the effectiveness of the camps. Their findings indicated that short-term camps promote scientific literacy. Nevertheless, the researchers suggested that these short-term camps should be followed by longer-term opportunities and additional activities for students, such as after-school programs, educational videos, and residential science camps. In the light of these suggestions, the intended implication was that enhancing scientific literacy was a long-term process. This point of view led to the conclusion that scientific literacy was connected with long-term learning components.

Literature about science education also investigated the components that could be related to, and enhance scientific literacy. One of the ways of understanding that emerged from an analysis of the comments in a study by Smith (2012) examining primary teachers' views of SL was that "scientific literacy was a way of engaging and motivating students to effectively learn science and work scientifically" (p. 142). Lotus diagrams revealed that it was important to promote curiosity for the development of scientific literacy.

In the knowledge and information laden 21st century society, it is crucial for all citizens to direct and regulate their own learning. However, this dimension is not sufficiently discussed in the literature on scientific literacy even though regulating one's own learning plays a greater role for citizens for evaluating an idea and a claim when they encounter various problems and search for new ways to solve problems (Choi et al., 2011). Considering this point of view, it could be concluded that scientific literacy was also related to regulation of learning.

Personal attributes, such as perseverance for learning can be significant for understanding science. However, these important attributes are often neglected in science education (Holbrook & Rannikmae, 2007; Holbrook, 2010). For the fulfilment this gap, self-determination and perseverance within learning need also to be included in the components that affect scientific literacy.

Life-long learning

Knapper and Cropley (2000) define life-long learners as active learners who plan and assess their own learning; learn in both formal and informal settings; learn from peers, teachers, and mentors; integrate knowledge from various disciplines; and use different learning strategies in different situations. Life-long learning tendency (LLT) then, can be defined as having the necessary knowledge, skills and values to plan and assess one's own learning, learn from others in both formal and informal settings by integrating knowledge from different sources and using different learning strategies. Coskun and Demirel (2010) identify four dimensions of LLT: motivation in life-long learning, perseverance, lack of regulated learning, and curiosity.

The dimensions of Miller's model contribute to students' SL are considered worthy of study. One way to do this is to focus on the relationship between SL and LLT in the light of Coskun and Demirel's four dimensions. Applying this approach in the case of science teachers, it is necessary to investigate whether the more teachers are curious, motivated, persevering, and regulated in their learning about scientific and environmental issues, the more they are scientifically literate. And as role models and mentors, it is especially important for teachers to be life-long learners.

Environmental literacy (EL)

Roth (1992) claims that the purpose of any educational program should be to develop and foster EL as well as SL. "Environmental literacy is essentially the capacity to perceive and interpret the relative health of environmental systems and take appropriate action to maintain, restore, or improve the health of those systems" (Roth, 1992, p. 1). The need for environmental literacy makes environmental education a necessity in schools.

Support for investigating EL in Turkey is found in earlier studies. For example, Erdogan and Ok (2011) investigated the EL of fifth-graders in Turkey and recommended additional assessment studies at sixth grade, twelfth grade, and university levels for a more complete picture of EL in Turkey. The recommendation might apply as well to pre-service science teachers, considering the effect they will have on the successive generations of students. One study assessing pre-service teachers' EL in Turkey was conducted by Tuncer et al. (2009) showing that pre-service teachers' environmental background was positively related to their EL. The researchers recommended further research to be conducted in other Turkish universities. Also after assessing pre-service teachers' EL in Turkey, Erdogan et al. (2009) recommended additional studies of this population. Other researchers in Turkey have focused on relationships among the components of EL (Kasapoğlu & Turan, 2008; Teksoz, Sahin, & Oztekin, 2012; Tuncer et al., 2009) and socio-demographic variables in relation to EL (Alp et al., 2008; Çakır, İrez, & Doğan, 2010; Tuncer et al., 2009). However, studies examining the relationship between EL and SL were rare.

As research about EE tends to highlight the importance of SL and EL, it becomes necessary to understand the ways in which these two forms of literacy are related. The relationship may enable cooperation between researchers in the field of EE and teachers of different disciplines in the design and implementation of educational programs.

Interdisciplinarity

In Turkey, as in US academic institutions were based on discipline-based approach till the end of the twentieth century. Scholars enrolled in academic disciplines in colleges and universities. Disciplinary associations were arranged to connect scholars and help them to advance their disciplines. However, departments and disciplines suffered from disadvantages over time. As disciplines and knowledge grew enormously, disciplinary cultures and perspectives began to constrain inquiries and explanations. These disadvantages gave rise to the emerging of interdisciplinarity in academic community (Lattuca, 2001).

While the 19th century in Turkey witnessed the increase in the disciplinary specializations and organizations, by the end of the 19th century, dramatic changes in the social, political, and economic changes of the Civil War years gave rise to beliefs in practical benefits of science. These developments helped to transform some classical colleges into research universities. World War II accelerated interdisciplinary research applications to service the military and politics. For example, the development of radar required the cooperation of scientists from various disciplines (Lattuca, 2001).

Interdisciplinary curricula in the US gained prominence from the 1960s. With the influence of the ecology movement at that time, Green Bay offered an interdisciplinary curriculum based on the relationships of people with their environment. From 1965, the University of Wisconsin organized its colleges around environmental themes rather than disciplines and students elected one of these majors to develop disciplinary expertise through a minor concentration. During 1970s and 1980s, interdisciplinarity reached a peak (Lattuca, 2001).

Although many definitions were put forward for interdisciplinarity, the definition in a broader sense allowing different epistemologies to coexist was adopted in this study: ‘Interdisciplinary is an adjective describing the interaction among two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration of organising concept, methodologies, procedures, epistemology, terminology, data and the organisation of research and education in a fairly large field. An interdisciplinary group consists of persons trained in different fields of knowledge (disciplines) with different concepts, methods, and data and terms organised into a common effort on a common problem with continuous intercommunication among the participants from the different disciplines (OECD 1972, pp. 25-26).’

Trumper (2010) suggested that environmental education in developing countries needed to aim at increasing future citizens’ capacity for a better quality of life by being environmentally sound, socially equitable, and economically affordable. This suggestion led to the conclusion that environmental education in developing countries should create citizens who were equipped with the knowledge and skills to have such a capacity. This approach to education needed to focus on interdisciplinarity between various disciplines.

The interdisciplinary approach is helpful for developing a better understanding of environmental issues (Villagra & Jaramillo, 1994). For example, individuals need to apply biological concepts to understand the needs of plants and animals, geography and geology to better understand ecosystems, chemistry to understand air pollution, metals, and metalloids in water, or chemical reactions in soil, etc. For this reason, cooperation between researchers and teachers from different disciplines may be helpful for teaching pre-service teachers about environmental issues.

Hudson (1985) pointed out that each discipline had a unique methodology and approach to problem-solving and suggested an integrated approach at the primary level, where the phenomena investigated and the conceptual structures were relatively simple; then gradually moving towards separate sciences by investigating them in a specialized and sophisticated way; and finally introducing interdisciplinary science to approach complex issues not falling into the domain of any science discipline. In this study, these complex issues might include environmental problems such as sustainability by using separate and sophisticated bodies of knowledge.

Labov, Reid, and Yamamoto (2010) refer to published templates and syllabi for interdisciplinary undergraduate courses, especially relevant to pre-service elementary and middle school teachers. Stressing the need to combine scientific knowledge and an effective teaching methodology, they call on science, mathematics, and engineering faculty and academic leaders in higher education to take a role in EE and to share in the responsibility for educating future teachers and researchers.

METHODOLOGY

Research Aims and Questions

The study addresses the interrelationship between SL and the variables of EL and LLT. It puts forward two research questions:

1. Is there a significant relationship between pre-service teachers' SL and EL?
2. Is there a significant difference between pre-service teachers' different levels of LLT in terms of SL?

In addition, the following hypothesis is put forward: if the answers to the research questions reveal significant relationships, one can conclude that cooperation between researchers and educators is needed to create life-long learners who are scientifically and environmentally literate.

Sample

Students (N=123) in their third year of a four year Preschool and Primary Teacher Education Program at a private university in Turkey participated in this study during the fall semester of 2012-2013. The students were male (N=11) and female (N=113) had taken and passed the national university entrance examination. Typical for this university, the students were from various regions of the country.

While, in general, students with higher scores on the entrance examination prefer to enter state universities, those with lower scores apply to private universities. For this reason, one would not expect students at the university where the study was conducted to have a strong background in science and environmental issues. The students had taken at least one course in science (physics, chemistry or biology) before they enrolled in the university and had taken at least one course in science education before the study was conducted. Thus, their disciplinary studies were relevant to the discussion of the results for this study.

Instruments

Three instruments were used in this study.

Test of Basic Scientific Literacy (TBSL)

The TBSL was developed by Laugksch and Spargo (1996) for the purpose of testing students' SL. While there were other instruments to choose from, most contain open-ended items and interview questions for assessing the quality of students' arguments in support of their positions (Zohar & Nemet, 2002; Grace, 2009; Dori, Tal, & Tsaushu, 2003; Walker & Zeidler, 2007) and were suitable for small-scale studies. The computer-based RCI Test developed by King and Karen (in Callahan, 2009), which assessed reflective judgments, was more suitable for large-scale studies (Sadler & Zeidler, 2009). On the whole, however, closed-ended items rather than open-ended items were more adaptable to surveys and large-scale assessments.

TBSL assesses the comprehension of the facts and concepts identified by AAAS as the knowledge that all high school leavers need to possess. It does not include items testing decision-making and problem-solving skills. However, little decision-making and problem-solving of any value can be conducted in the absence of factual and conceptual knowledge. So, TBSL, which is both valid and reliable, can be used in large-scale studies with relatively little expense in time and money (Laugksch & Spargo, 1996). Although it is an old instrument, it is regarded as an effective scale for assessing the understanding of the facts and concepts that was determined for this study.

Table 1 indicates the number of items in the test as a whole and in the sub-scales. It also gives the KR reliability coefficient when the tests were used in other studies. All items were of the true, false, don't know type.

Table 1 Items and reliability of the TBSL test

TBSL Test / Sub-test	No of items	KR (Cavas, 2009)	Cronbach's alpha (Cavas et al., 2013)
Total	110	0.89	0.92
Nature of science	22	0.73	0.60
Scientific knowledge	72	0.81	0.60
Impact on science and technology	16	0.71	0.91

The test consists of 110 items requiring a response of 'true', 'false', or 'don't know'. The true-false format is suitable for content requiring a large number of items. The addition of a 'don't know' option reduces the probability of guessing. The test consists of three subtests based on Miller's dimensions of SL: the nature of science (e.g., 'Science assumes that the basic rules about how the universe operates are the same throughout the universe'); scientific knowledge (e.g., 'Compared to the Earth's diameter, a very thick blanket of air surrounds the entire Earth'); and the impact of science and technology on society (e.g. 'Social and economic forces within a country have little influence on what technologies will be developed within that country'). The TBSL was translated and adapted into Turkish by Cavas (2009).

The Scale of Environmental Literacy (SEL)

The SEL, developed by Kaplowitz and Levine (2005), was translated and adapted for use in Turkey by Tuncer and colleagues (2009) (Table 2).

Table 2 Items and reliability of the SEL test

TBSL Test / Sub-test	No of items	Cronbach's alpha (Tuncer et al., 2009)
Total	49	-
Environmental knowledge	11	0.88
Environmental attitudes	10	0.64
Perception of environmental uses	19	0.80
Environmental concern	9	0.88

The scale consists of 49 items in four dimensions: environmental knowledge (e.g. 'Which of the following household wastes is considered as hazardous waste?: 1, plastic packaging; 2, glass; 3, batteries; 4, spoiled food; 5, don't know'); environmental attitudes (e.g. 'We are approaching the limit of the number of people the Earth can support'); perception of environmental uses (e.g. 'Wild animals that provide meat for people are the most important species to protect'); and environmental concern (e.g. 'Identify your level of concern about the following environmental issues: smoke pollution; noise pollution; automobile emissions; etc.').

The knowledge component of the scale assesses the pre-service teachers' knowledge of current environmental issues; the environmental attitude items assess their feelings and values related to the environment; and the environmental use items assess their intention to participate in pro-environmental behaviour; and the environmental items assess their sensitivity toward environmental problems and issues (Tuncer et al., 2009).

The dimension of environmental knowledge is composed of multiple-choice items. Each correct response receives a score of 1; incorrect responses receive 0. Scores range from 0 to 11. The rest of the instrument consists of Likert-type items with a range of 5, 'strongly agree'; 4 'agree'; 3 'undecided'; 2, 'disagree'; and 1, 'strongly disagree'. Some items are negatively stated, giving 'strongly disagree' 5 points and 'strongly agree' 1 point.

Tuncer et al. (2009) uses the scale to assess pre-service teachers' environmental literacy in preparation for the development of teacher education programs in Turkey. In the present study, the scores for each dimension of SEL are analysed separately, because the environmental knowledge dimension is composed of multiple-choice items while the rest of the scale is composed of Likert-type items.

Lifelong Learning Tendency Scale (LLTS)

The LLTS was prepared by Coşkun and Demirel (2010) (Table 3).

Table 3 Items and reliability of the LLTS test

TBSL Test / Sub-test	No of items	Cronbach's alpha (Coskun & Demirel, 2009)
Total	27	0.89
Motivation	6	-
Perseverance	6	-
Regulating learning	6	-
Lack of curiosity	9	-

The scale consists of 27 Likert-type items with a range of 6, 'very suitable'; 5, 'partly suitable'; 4, 'very slightly suitable'; 3, 'very slightly not suitable'; 2, 'partly not suitable'; and 1 'not suitable'. It has four dimensions: motivation (e.g., 'continuously learning new information is a desire for me'); perseverance (e.g., 'I like to spend most of my time researching for learning'); lack of regulating learning (e.g., 'Self-evaluation about my own learning does not enable me to learn new subjects'); and lack of curiosity (e.g., 'I think libraries are boring places'). Of these, items in the first two dimensions are composed of positive statements and those in the next two dimensions are composed of negative statements. The examples given in parentheses have been translated from Turkish into English by the author.

This instrument was selected for use in the study because it addresses appropriate components of a life-long learning tendency.

Research Design and Procedure

The TBSL and SEL scores were analysed for correlation. To test for the difference between their levels of LLT in terms of SL, the range of LLT scores was divided into four levels, and then the TBSL scores at each level were compared. Pearson correlations and ANOVA were used to evaluate the data. Hypotheses were tested at the 0.95 level of confidence. All instruments were administered to all participants. SPSS was used for all statistical analysis.

FINDINGS

Research Question 1

The mean scores of each dimension of SEL is given in Table 4. The maximum value possible was 110.

Table 4 The mean scores of the dimensions of SEL

TBSL Test / Sub-test	Mean scores
Total	49.50
Environmental knowledge	6.63
Environmental attitudes	40.38
Perception of environmental uses	77.90
Environmental concern	37.32

The relationship between participants' SL and EL was examined by means of a Pearson correlation coefficient comparing scores from the TBSL with those from the SEL (Table 5).

The Pearson correlation coefficients indicate a relatively low but significantly relationship greater than zero between the total scores of the TBSL and the scores of the SEL in all dimensions ($p<0.05$).

Table 5 Correlation between scientific literacy and environmental literacy (N=123)

		Scientific literacy	Environmental knowledge
Scientific literacy	Pearson correlation	1	0.337*
	Sig. (2-tailed)		0.000
Environmental knowledge	Pearson correlation	0.337*	1
	Sig. (2-tailed)	0.000	
		Scientific literacy	Environmental attitudes
Scientific literacy	Pearson correlation	1	0.256*
	Sig. (2-tailed)		0.004
Environmental attitudes	Pearson correlation	0.256*	1
	Sig. (2-tailed)	0.004	
		Scientific literacy	Environmental uses
Scientific literacy	Pearson correlation	1	0.201*
	Sig. (2-tailed)		0.026
Environmental uses	Pearson correlation	0.201*	1
	Sig. (2-tailed)	0.026	
		Scientific literacy	Environmental concern
Scientific literacy	Pearson correlation	1	0.211*
	Sig. (2-tailed)		0.019
Environmental concern	Pearson correlation	0.211*	1
	Sig. (2-tailed)	0.019	

*p<0.05

Research Question 2

The Pearson correlation coefficient did not show a relationship significantly greater than zero between the scores of LLTS and SL (p>0.05). However, there can still be some differences in SL of the students in different levels of LLT. Thus the students were assigned to four levels based on LLTS percentiles. A one-way ANOVA was used to test for differences among these levels in terms of SL. Table 6 shows percentiles of LLTS scores and Table 7 shows the mean scores of SL at the four levels of LLT.

Table 6 Percentiles of the scores of LLTS

	Percentiles			
	0-25	25-50	50-75	75-100
Life-long learning (x)	$x \leq 81$	$81 \leq x \leq 87$	$87 \leq x \leq 93$	$93 \geq x$

From table 2 it is possible to deduce that 50% students obtained scores in the 81 to 93 range. This is further illustrated in figure 1.

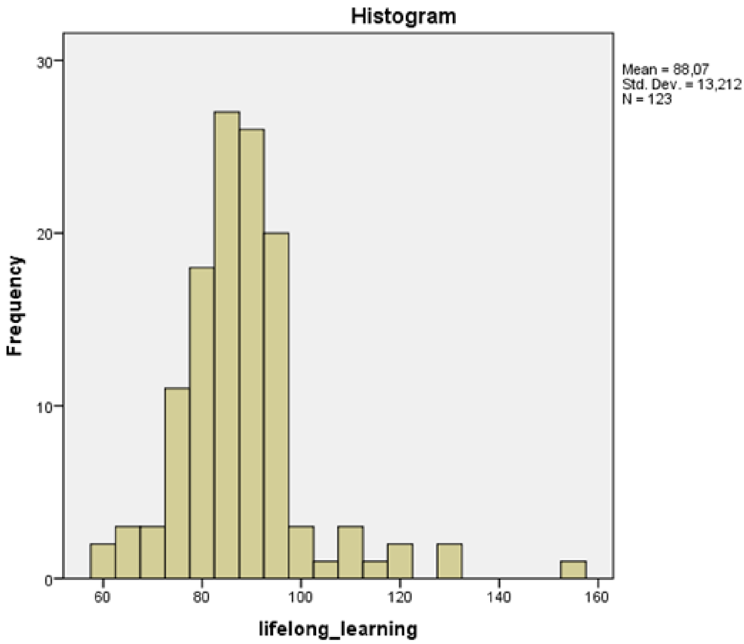

Figure 1 Frequencies of life-long learning tendencies

Figure 1 shows frequencies of life-long learning tendencies among the participants. The mean score from the LLTS was 88.07. The maximum value possible was 162. It is evident from this result that the participants' perception of their life-long learning tendency hovers around the moderate level.

As shown in Table 7, the mean scores of all participants reveal a moderate level of scientific literacy. The mean SL scores of participants in the third quartile are higher than those in other quartiles.

A one-way ANOVA was used to examine the significance of this difference. The results, shown in Table 8, reveal a significant difference between the first and the third quartiles ($p<0.05$) while no significant difference was found between other levels of LLT in terms of SL ($p>0.05$).

Table 7 Mean scores of scientific literacy for the four levels of life-long learning tendency

	N	Mean	SD	Std. error	95% confidence interval for mean Lower bound	Upper bound	Min.	Max.
1	29	53.76	15.26	2.83	47.96	59.56	19	78
2	26	58.00	13.89	2.72	52.39	63.61	31	84
3	35	66.26	15.32	2.59	60.99	71.52	23	90
4	33	58.52	15.89	2.77	52.88	64.15	34	83
Total	123	59.49	15.69	1.42	56.69	62.29	19	90

This finding indicates that there is some relationship between SL and LLT. However, it is not evident from this study that the higher the level of LLT the higher the SL, because the students at the fourth level of LLT do not seem to be more scientifically literate than those at the other three levels.

Table 8 Difference between four levels of life-long learning tendency in terms of scientific literacy

	Level	Level	Mean difference	Std. error	Sig.	95% confidence interval Lower bound	Upper bound
ANOVA Turkey HSD	1	2	-4.24	4.10	0.73	-14.92	6.44
		3	-12.50*	3.81	0.01	-22.43	-2.57
		4	-4.76	3.86	0.61	-14.82	5.31
	2	1	4.24	4.10	0.73	-6.44	14.92
		3	-8.26	3.93	0.16	-18.49	1.98
		4	-0.52	3.98	1.0	-10.88	9.85
	3	1	12.50*	3.81	0.01	2.57	22.43
		2	8.26	3.93	0.16	-1.98	18.49
		4	7.74	3.68	0.16	-1.85	17.34
	4	1	4.76	4.10	0.61	-5.31	14.82
		2	0.52	3.98	1.0	-9.85	10.88
		3	-7.74	3.68	0.16	-17.34	1.85

*$p<0.05$

DISCUSSION

In order to cope with today's challenges to the environment, people, both individually and collectively, need sufficient knowledge about social, political, and environmental issues. It follows that pre-service teachers, entrusted to prepare future generations at a critical stage of human survival, also need to acquire this knowledge (Martins, 2011). They need both SL and EL. This study shows that there is a relatively low but significant relationship between SL and all the dimensions of EL. This finding is consistent with a study conducted by Crall and colleagues (2012), who found that instruction related to invasive species conducted at the University of Wisconsin Arboretum and the Colorado State University Environmental Learning Center resulted in improved SL. However, research examining the effect of EL instruction on SL is rare. Further investigation is needed, not only in the dimensions of knowledge, attitude, and perception of environmental uses, but also in the dimension of environmental concern, as addressed in this study.

Findings from this study show a relationship between SL and LLT. Those participants who had LLT scores between 87 and 93 have higher SL than participants who scored 81 or less, while no difference at other LLT levels was found. The SL of participants at the third level of LLT differed significantly from the SL of those at the first level. This finding leads to the conclusion that education aimed at raising students' LLT scores from 81 or below to at least 87 is likely to raise their level of SL.

The results indicate that the SL of the participants who have the highest level of LLT did not differ significantly from the SL of those at the other levels of LLT. A possible explanation is that these participants may not be aware of their learning tendency and even their LLT is not significantly different from others their perception of their LLT is optimistically high. Future studies investigating students' SL and LLT may bring deeper insight to this issue.

Although no significant difference were found in the participants' SL at the other levels of LLT, the significant difference between the first and the third level leads to the conclusion that education should aim at raising students' perception of their LLT. Education from the early grades to higher education should put emphasis on of life-long learning through inquiry activities that arouse curiosity about environmental issues and engage students in the methodologies of various disciplines. The interdisciplinary approach to teaching may help learners at any level to regulate and extend their learning beyond the classroom, thus raising their life-long learning tendencies and their levels of SL.

The findings of the present study show a significant relationship – not linear, however – between SL and LLT and between SL and EL. Gough (2002) recommends a reconsideration of science education as a 'host' for EE, changing the science curriculum so that it has a mutually beneficial relationship with EE. EE is interdisciplinary in nature. This means that science educators can help students to shift their thinking from one discipline to another, not only among the disciplines of 'pure' science, but also among the disciplines of social science. This result is consistent with the findings of other researches pointing out the necessity of integration of

EE across the subject disciplines in teacher education programs (Lieberman & Hoody, 1998; Sia, 1992; Rohweder, 2004; Zorilla-Pujana & Rossi, 2014).

Innovative approaches that promote the inquiry-based model may be helpful for this kind of integration.

Bursztyn and Drummond (2014) contend that more interactions are needed between universities and non-academic research institutions. Unfortunately, the Turkish educational system lacks this sort of cooperation. It also fails to produce scientifically literate citizens. According to the results of PISA 2012, 15-year-olds in Turkey had a mean score of 463 points in science literacy compared to a mean of 501 points for all OECD countries (OECD, 2012-2013). Turkish authorities could remediate the deficiency by constituting working teams from the different disciplines who are charged with the task of developing educational programs that are likely to produce scientifically and environmentally literate citizens who are life-long learners. Teacher education programs in universities should foster this cooperation.

A longitudinal study of LLT, SL, and EL at successive grade levels can help us develop a deeper understanding of these relationships. Also, forums in which in-service teachers inquire into complex issues such as environmental problems in collaboration with educators and researchers from different disciplines may bring new insights to the development of SL, EL and LLT.

CONCLUSION

The findings of the present study show that pre-service teachers' SL and LLT hovers around moderate level. The results also indicate a moderate level for their environmental knowledge, while they seem to have quite high environmental attitude, perception of environmental uses, and environmental concern. The findings of this study also indicate a relatively low but significant relationship between SL and all the dimensions of EL.

Although there was not a significant correlation between pre-service teachers' SL and LLT, the findings reveal a significant difference between the first (who scored 81 or less) and the third quartiles (who scored between 87 and 93) while no significant difference was found between other levels of LLT in terms of SL. This finding indicates that there is some relationship between SL and LLT.

Limitations of the study

Pre-service teachers' environmental behaviour was not measured in this study. The dimension of perception of environmental uses in SEL was assessed based on the assumption that the participants' intention to take part in pro-environmental behaviour is related to their actual behaviour. Further research investigating environmental behaviour by observing the behaviour directly is needed.

The methodology of this study was descriptive and quantitative research. Further research employing interviews, observations, and other types of qualitative research methods may shed additional light on the status of EL in Turkey.

Recommendations

Mutisya and Barker (2011) recommends the Ministry of Education in Kenya to develop and implement an EE policy that facilitates collaboration between schools and community to take part in conserving their environments. This kind of policy is also necessary for Turkey to create responsible citizens who partake in pro-environmental behaviour. This paper argued that this kind of behaviour can be achieved through interdisciplinary approach. In the present study three variables, namely SL, EL, and LLT are investigated for the implementation of interdisciplinarity in environmental education. Other variables that may affect this implementation need to be investigated in further researches.

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