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Comparison of the Main Determinants Affecting Environmental Literacy in Singapore, Estonia and Germany

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ABSTRACT

The purpose of this research is to determine and compare the variance of the main factors affecting the environmental literacy of fifteen-years-old students studying in Singapore, Estonia and Germany. The relational model, which is one of the quantitative research approaches, has been adopted in this study. Through the relational model, the main factors affecting the environmental literacy averages of the sample countries and the degree of the effect of these factors have been investigated. As the research design, a survey method that provides the opportunity to work with a large sample was used. In this study, the universe was 15-years-old German, Singaporean and Estonian students. The sample consisted of 6.504 German, 6.115 Singaporean and 5.587 Estonian students. The data based on the findings of the PISA 2015. In this study, the researchers used *Environmental Literacy Scale* developed by researchers. It was also classified by the researchers to determine the basic determinants affecting environmental literacy. In the light of the selected determinants, it is concluded that in all three countries there is a low but significant relationship between environmental literacy and the determinants affecting the environmental literacy. In Estonian case, there are various factors affecting environmental literacy furthermore, the total variance ratio is lower than the other two countries. In German case, the determinants (extra-curricular activities, teacher's teaching skills etc.) affecting environmental literacy were few and the variance rate was about the same as that of Singaporean. "Extra-curricular activities" is the determinant which had the most significant positive impact on environmental literacy among students in all three countries.

Keywords: environmental literacy, science education, country-comparative study

INTRODUCTION

Literacy, especially the environmental literacy, is one of the important concepts for the improvement of sustainable development awareness of future generations. Thus, studies in the field of environmental literacy, analysing the positive practices of different countries in environmental education may contribute to the future generations' awareness towards nature. Therefore, this study includes both the comparison of environmental literacy and the concept of environmental literacy of the countries selected by the researchers. For a better understanding of the subject, firstly, the environmental literacy and factors affecting literacy will be explained. Then information concerning the importance and purpose of this study will be given in the following paragraphs.

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Environmental Literacy

Since the 1970s, the concept of environmental literacy arisen as a concept that has to be taken into consideration in the solution of the environmental problems (Ozturk, Tuzun, & Teksoz, 2013). Nevertheless, after nearly twenty years (in the 1990s), the concept of environmental literacy witnessed the improvement of environmental education (McBeth & Volk, 2010). In fact, although there is no universal definition (Loubser, Swanepoel, & Chacko, 2001; Morrone, Mancl, & Carr, 2001), researchers have divided environmental literacy into various categories. In one of these studies, environmental literacy has four major components: knowledge skills, affect and behaviour (Roth, 1992). In another study, it is mentioned that environmental literacy (EL) has five categories of concepts including; awareness, knowledge, attitude, skills, and participation (Wisconsin Department of Public Administration, 1991). According to PISA analyses, the categories of environmental literacy involve awareness, responsibility and optimism towards the environment (Kaya & Elster, 2017a) as well as the development of environmental behaviour (Kaya & Elster, 2017b).

In order to have a more sustainable prospect in the future by the societies, some of the studies related to environment in science education are carried out to define and classify the environmental literacy. Environmental literacy is regarded as a conscious management and use of natural resources at individual level (Bennett & Roth, 2015), studies on environmental literacy will continue to achieve this aim at the desired level.

Purpose of Study

A good formal education should be assessed through including the performances of the students (Modupe, 2012). This might be an effective feedback of the success of the educational system. A similar situation is generally viable for both science education and especially for the environmental education. It is assumed that the determination of factors raising more qualified environmental literate individuals should be taken into consideration. In addition, the proposal of solutions in this direction will lead to the increase of the quality of formal education as well as the protection of existing natural resources. Moreover, in order to improve the quality of environmental education, it is expected that more comprehensive solution proposals will be put forward to train qualified environmental literate individuals as they are obtained from the data of the international study PISA. The purpose of this study is to determine the factors affecting environmental literacy in Germany, Estonia and Singapore. A further aim is to compare the factors which are affecting the environmental literacy in these countries. These countries are chosen because when the PISA 2015 data are analysed the highest average among participants in science literacy was in Singapore and Estonia had highest average among the participants of the European countries (OECD, 2016).

Review of Literature

The factors affecting literacy are given under four main headings including; the effects of the family, teacher, student and teaching.

The effects of the family

Empirical studies have proven that "Family" is the main factors influencing the quality of education, student achievement and literacy. Apart from the education given in the school, it seems that parents have an active role on the success of the students (Aslanargun, 2007; Cagdas, Ozel, & Konca, 2016). When Hattie's study is analysed, one of the obvious family-related factors is socio-economic characteristics and the other is the participation of the family (Lotz & Lipowsky, 2015). Families involved in the child's education process, are supporting to make positive development both in themselves and in their children and also in educational institutions (Cagdas, Ozel, & Konca, 2016). However, the educational achievement of the family is regarded as an important factor in order the child to be effectively involved in the educational process (Henderson, 1987; Usher & Kober, 2012). Furthermore, economic, social and cultural structures not only affect education but also environmental literacy (Lin and Shi, 2014). It is stated that there is a meaningful and positive relationship between socio-economic level of the family and environmental literacy (Kaya & Elster, 2017a). To sum up, family-related factors should be taken into consideration in order students to be more successful and more qualified environment literate individuals.

The effects of the teacher

In the life of students, there are two basic educators: their parents and their teachers (Department for Children, Schools and Families, 2008). For this reason, the effectiveness of the teacher has often been a matter

of debate in former and current times (Kaya, Godek Altuk, & Bahceci, 2012; Kisakurek, 2009; Tatar, 2004). The focal point of these discussions is to get the better education for the students (Kaya, Godek Altuk, & Bahceci, 2012).

Increasingly broadening teacher competencies are influential on student achievement, particularly the teacher's tendencies and competencies related to teaching, classroom management, academic support and attitudes towards his/her student. The teacher should use effective methods and appropriate materials in the teaching process therefore students can acquire the necessary skills and perform effective learning (Simsek, Hirca, & Coskun, 2012). For example, student-cantered teaching methods, such as creative drama (Akdemir & Karakus, 2016; Batdi & Batdi, 2015), 5E teaching methods (Acisli, Altun Yalcin, & Turgut, 2011; Crider, 2013), and inquiry-based learning (Simsek & Kabapinar, 2010), are generally more likely to impact academic achievement than traditional teaching methods. Therefore, in order to enable the teacher to use the teaching process effectively, professional development should be supported by starting from the pre-service and including in the process (Kaya & Gödek, 2016).

In addition to teaching methods, the teacher's academic support to students and attitudes towards them and classroom management are also affecting student success. For this reason, an effective teacher ought to know his/her students well and show their love towards them (Sahin, 2011). In addition, the instructor should motivate his/her student by guiding him/her and encourage them to learn within the teaching process. When the teacher has effective in the sense of professional development, effective teacher behaviour might be demonstrated and effective classroom management might be realized (Can, 2004). For this reason, the influence of the teacher on the success of education must be considered.

The effects of the student

One of the factors affecting literacy is the student himself. In addition to the students' attitudes towards the school and lessons, and the anxiety of the exam, there are various factors influencing the students' success. Attitudes are regarded as one of the affective characteristics that affect learning (Yasar & Anagun, 2008) so that, students' attitudes towards science affect students' success in science (Unal & Ergin, 2006). However, education systems force students unnecessarily, it causes students to develop negative attitudes towards reading, teaching and learning (Moore, 2004). The cause of negative effects is not only related to the personality of the student, but also the qualities (content knowledge and pedagogical knowledge) of the teacher (Tomal, 2010). In order to become lifelong learners, students should be supported in terms of their knowledge, understanding and attitudes towards natural sciences (Kaya & Boyuk, 2011).

The effects of the teaching

Another important factor affecting literacy is teaching. Diversity in teaching methods and forms, and effective planning of the process, are the factors that affect both the literacy and the success of the student. Therefore, it is necessary to apply teaching methods and techniques in the right place and at the right time by observing the characteristics of the teaching environment (Yasul & Samancı, 2015). For instance, a teacher who teaches teamwork in his/her classroom should allow the students to solve the problems in pair, get mutual feedback, and share information with other members of the group (Hevedanlı & Akbayın, 2006).

For the student success not only formal learning process but also informal process learning are important. Extra-curricular activities in students' development, activities that reinforce students' learning in the formal learning process, demonstrate that these learnings are related to life, and put the theoretical learning into practice (Kose, 2013). For this reason, many educational institutions, especially in the field of science, provide their students with extra-curricular learning experiences, (Bostan Sarioglan, & Kucukozer, 2017; Eastwell & Rennie, 2002). In this way, students are able to learn by doing actively, gain an inquisitive point of view and use scientific process skills (Ay, Anagün, & Demir, 2015). In conclusion, education and training are not only limited to schools, but also out-of-school processes. For this reason, it is important to consider that effective use of out-of-school activities will have the opportunity to raise qualified literate individuals, especially environmental literate individuals.

Previous Research in Factors Influencing Literacy

Yildirim (2012) used the PISA 2006 data and found that the factors determining education quality in Turkey were family factor (% 52), student characteristics factor (%14), teaching process factor (% 6) and institutional environment factor (%1.4). In another study, it was found that there was a positive and statistically significant impact of learning facilities, communication skills and proper guidance from parents

on student academic performance (Singh, Malik, & Singh, 2016). In Becker and Luthar's study (2002), it was stated that academic and school attachment, teacher support, peer values, and mental health are influential on achievement performance. In another study, it was found that socio-economic, psychosocial, school and home environment and student's own factors, affected their academic performance (Habibullah & Ashraf, 2013). In addition, attitudes towards science affects the success (Akpınar, Yıldız, Tatar, & Ergin, 2009; Ali, Iqbal, & Akhtar, 2015; Criker, 2006). In the meta-analysis study Hattie (2009) examined five basic categories of situations that affect learning which are home, student, school, curricula, and teacher. In another meta-analysis study, the school-related factors affecting the academic achievement were found by Sarier (2016), as 0.23 for the effect size of the students; student-related factors were found as 0.32; and family related factors were found as 0.27. Furthermore, the most important factors affecting the academic success of the students were found to be socio-economic status, self-efficacy and motivation.

In addition, the literature also includes studies on factors affecting both academic and science achievement. In Anıl's study (2009), it was determined that the variables that most predict students' success in science in PISA 2006 data were 'the educational status of the father', 'the attitude towards science', and 'the computer environment'. In his study, Anıl (2011) determined that the most important variable that determines the success of the students' science achievement and the most important factor determining success were 'time', 'environment', 'education' and 'attitude'. In a study conducted with 10th grade students (300 male and female), Farooq et al. (2011) found that socio-economic status (SES) and parents' education had a significant effect on students' overall academic achievement. In Sayin and Gelbal's study (2014), the most important factors in the success of the teacher candidates were found to be the good listening skills, disciplined work, the strategies and methods applied with teacher competencies; the less important factors were found to be the number of siblings, computer skills and participation in social activities.

Similar results have been obtained in studies conducted in different interdisciplinary fields. In one of these studies, it has been seen that there was a relationship between the income level of the family, the attitude towards the course and mathematics success. In Demir, Kılıç, and Depren's study (2009), the student background, learning strategies, self-related cognitions in mathematics and school climate factors under study totally accounted for approximately 34 percent of the variance in mathematics achievement. All of the factors had statistically significant effects on the achievement. Lamb and Fullarton (2001) mentioned that according to TIMSS data, classroom differences account for about one-third of the variation in mathematics achievement in the United States and over one-quarter in Australia.

Research Questions

The purpose of this research is to determine the variance of the main factors affecting the environmental literacy of the fifteen-years-old students in Germany, Singapore and Estonia. Within the scope of this aim, answers to the following questions were sought:

- What are the main factors influencing the environmental literacy of the students in the age group of fifteen in Singapore, Estonia and Germany? How is the similarity between countries considering whether they are statistically significant or not?
- How much of the explained variance of the students' perceptions of environmental literacy averages is explained by the main factors covered in this research? How are the rates of disclosure compared to the countries?

RESEARCH METHODS AND DESIGN

In this section, the type of study, sampling, data collection and the data analysis will be explained.

Type of Study

The relational model, which is one of the quantitative research approaches, has been adopted in this study. Through the relational model, it was tried to determine the main determinants affecting the environmental literacy averages of the sample countries and the degree of the effect of these factors. As a research design, a survey method that provides the opportunity to work with a large sample was used. Survey method is a research aimed to identify the views and the situations of large masses (Buyukozturk, Kilic Cakmak, Akgun, Karadeniz, & Demirel, 2008).

Sample and Sampling

When the sample is determined, it is also aimed to specify and compare the main factors affecting the environmental literacy of the students in Germany, Singapore and Estonia. The reason for comparing the environmental literacy of German students to Singaporean and Estonian students is that when the PISA 2015 data are analysed the highest average among participants in science literacy was in Singapore and Estonia had highest average among the participants of the European countries (OECD, 2016). For this reason, these three countries were compared in regard to environmental literacy. In this study, the universe was 15-years-old German, Singaporean and Estonian students. The sample consisted of 6.500 German students, 6.115 Singaporean students and 5.587 Estonian students. PISA 2015 data were obtained on the internet from the official PISA web site (http://www.pisa.oecd.org) are used.

Measures

In this study, environmental literacy scores of the students were considered as dependent variables. Researchers used Environmental Literacy Scale developed by Kaya and Elster (2017b) to calculate students' scores. According to Kaya and Elster (2017b), the remaining 15 items were loaded on the 3 factors labelled environmental responsibility, development of environmental behaviour, and environmental awareness. Item loads larger than 0.61 were chosen and included in the environmental literacy scale. In the first part of developing the scale, exploratory factor analysis, was used to examine the construct validity of the scale as described above In the second part, confirmatory factor analysis, was used to show the relationships between variables. According to results of confirmatory factor analysis, the significance value was found to be .00, as well as, the P-values and most of the other values may be interpreted as indicating good fit.

Moreover, as some independent variables, they are considered as the main determinants affecting literacy. The 71 items selected from the student questionnaires in the PISA data were also classified in 14 categories by the researchers to determine the basic determinants affecting literacy. The following paragraph makes a more detailed knowledge of classification of factors.

Classification of the main determinants affecting literacy

Even though the validity and reliability of PISA tests and questionnaires are achieved through different approaches (Yildirim, 2012), in the first part of the classification of main determinants, exploratory factor analysis with SPSS software was used to examine the construct validity of the scale. Exploratory factor analysis (EFA) are widely used in education (Taherdoost, Sahibuddin, & Jalaliyoon, 2014) and statistically used in this study. EFA is normally the first step in building scales or a new metrics (Yong and Pearce, 2013). Before the items are classified, due to some of the items in this study are categorical variables, they are included in the analysis by converting them into new artificial variables called "dummy" variables. Since, the observation of the effects of the qualitative variables on the dependent variable may be analysed after such variables are defined as "dummy" variables (Buyukozturk, 2009). To determine whether or not to perform factor analysis, the Kaiser-Meyer-Olkin (KMO) Value and Bartlett's test of sphericity were calculated before the exploratory factor analysis. The KMO and Bartlett results are shown in **Appendix 1**. KMO values over 0.50 (KMO=0.90, $p<0.01$) indicate that factor analysis sampling was appropriate. Bartlett's test of sphericity was significant at (104.010,774) $p<.01$, showing that the tool can be differentiated into factor structures. Using the t-test for the reliability of the meaningfulness of the median of the top 27% and bottom 27% groups were determined. While there are fourteen determinants in the graph with a high acceleration, the general trend of the graph in the fifteenth and subsequent determinants are horizontal, and they have no significant declining trend (**Appendix 2**). Analyses of the factors were done with 14 determinants and 71 items. The total variance of the factors was 61.17%. Furthermore, those item loads larger than 0.44 were chosen and included in the classification. Any item was not excluded from the classification of the main determinants because it was not a disassociated item and the remaining 71 items were loaded on the 14 determinants labelled;

Determinant 1 – Extra-Curricular activities (ECA) (1, 2, 3, 4, 5, 6, 7, 8 and 9)

Determinant 2 – Teacher's Teaching Skills (TTS) (10, 11, 12, 13, 14, 15, 16 and 17)

Determinant 3 – Attitude toward Science (ATSci) (18, 19, 20, 21 and 22)

Determinant 4 – Attitude towards School (ATSch) (23, 24, 25, 26, 27 and 28)

Determinant 5 – Teacher's Feedback for Academic Development of Student (TFADS) (29, 30, 31, 32, 33)

Determinant 6 – Attitude of Teachers towards the student (ATTS) (34, 35, 36, 37, 38 and 39)

Determinant 7 – Interest in Science Content Knowledge (ISCK) (40, 41, 42, 43 and 44)

Determinant 8 – Test Anxiety of Student (TAS) (45, 46, 47, 48 and 49)

Determinant 9 – Education Support of Parents (ESP) (50, 51, 52 and 53)

Determinant 10 – Teacher's Disposition to Teaching (TDT) (54, 55, 56 and 57)

Determinant 11 – Teamwork (TW) (58, 59, 69 and 61)

Determinant 12 – Class Management (CM) (62, 63 and 64)

Determinant 13 – Socio Economic Characteristics (SEC) (65, 66, 67, 68 and 69)

Determinant 14 – Educational Level of Parents (ELP) (70 and 71).

Data Analysis

While main determinants were classified, exploratory factor analysis was tested. Moreover, the linear trend method was used to complete the missing data. Multiple regression analysis was used in one of the patterns that examine the effect of the measurable and non-measurable independent variables on the dependent variable (Buyukozturk, 1997). However, this does not mean the causality of relations (Tabachnick & Fidell, 2015). Standard regression analysis and Stepwise regression analysis were tested by the measurement of the variance factors affecting environmental literacy.

It is also examined that the correlation between independent variables and dependent variable are not higher than 0.80. It is stated that regression analysis can be performed when the correlation value is not higher than 0.80 (Buyukozturk, 2009). Moreover, when the assumptions of linearity and normality are examined, it is seen that the maximum value of The Variance Inflation Factor (VIF) values in German students is between 1.03 and 1.68 (VIF value), between 1.04 and 1.41 for Estonian students and between 1.03 and 1.45 for Singaporean students. The VIF is widely used measures of the degree of multi-collinearity in a regression model (O'Brien, 2007). 1 <VIF $\leq$ 5 indicates moderate multi-link and the model correction is not required (Karagoz, 2016). In addition to the values of the sequential residual terms must be independent from each other and it is examined that whether there is an autocorrelation between the values with Durbin-Watson test (Yavuz, 2009). It is also expected that the Durbin-Watson coefficient of the regression analysis is between 1.5 and 2.5. (Karagoz, 2016). It is seen that the model established for Germany is 2.00, while the model established for Estonia is 1,89, and for Singapore 1,92. On the other hand, the P-P plot is theory-driven graphical methods for testing normality (Park, 2006). The results obtained in **Appendix 3** and P-P Plot images show that the regression analysis is normally distributed. Moreover, according to scatter plots examined, it is accepted that if the error terms (residuals) on the graph randomly scattered around zero, it shows that the variance in the error terms is constant (Rudy, 2011; Sezer, 2016). The possible relationship between continuous dependent and independent variables should always be based on scatter plot (Schneider, Hommel, & Blettner, 2010). Therefore, the results of the scatter graph images show that the regression analysis is linearity and the variance in the error terms is constant.

RESULTS AND COMMENTS

Findings obtained from this research are shared in separate sections.

Findings related to German Students

As shown in **Table 1**, it was found that there is a meaningful relationship between total variance of 14 predictive variables and environmental literacy ($F(14, 2319) = 43.34$ $p < .01$). These variables clarified for approximately the 21% of the total variance in environmental literacy, the dependent variable. While the main determinants influencing environmental literacy positively in Germany are "extra-curricular activities" and "teacher's teaching skills"; the "teacher's disposition to teaching" determinant is the most negative determinant.

Table 1. Regression analysis of environmental literacy of German students

Determinant	B	Std. Er.	Beta	T	P	Zero-Order	Partial
Constant	2.064	.121		17.072	.000	-	-
Extra-Curricular Activities	.123	.013	.202	9.393	.000	.315	.191
Teacher's Teaching Skills	.129	.016	.158	7.877	.000	.267	.161
Attitude toward Science	-.026	.009	-.068	2.852	.004	-.253	-.059
Attitude towards School	.026	.022	.022	1.178	.239	.038	.024
Teacher's Feedback for Academic Development of Student	-.047	.011	-.093	4.387	.000	-.267	-.091
Attitude of Teachers towards the student	.000	.011	.001	.029	.977	.062	.001
Interest in Science Content Knowledge	-.049	.025	-.042	1.952	.051	-.178	-.040
Test Anxiety of Student	.033	.009	.070	3.657	.000	.117	.076
Education Support of Parents	-.032	.011	-.054	2.811	.005	-.111	-.058
Teacher's Disposition to Teaching	-.062	.010	-.133	6.275	.000	-.280	-.129
Teamwork	-.005	.010	-.010	.539	.590	-.038	-.011
Class Management	.005	.009	.012	.608	.543	-.052	.013
Socio Economic Characteristics	.023	.015	.030	1.583	.114	.004	.033
Educational Level of Parents	-.003	.008	-.008	.436	.663	.015	-.009

$R= 0.46$, $R^2 = 0.21$, $F_{(14, 2319)} = 43.34$, $p < .01$

According to stepwise regression analysis, the mathematical model is demonstrated below: (**Appendix 4**):

$$\textit{Environmental Literacy} = 2.166 + .13*(ECA) - .06*(TDT) + .13*(TTS) - .05*(TFADS) - .03*(ATSci) + .03*(TAS) - .03*(ESP)$$

Seven steps have been included in the multiple regression analysis; however, 19% of 20% of the total variance in environmental literacy describe the variables in the first 4 steps. "Extra-curricular activities" are the predictor variables that provide the highest contribution to the regression equation and the explanation rate is 10%.

Findings related to Singaporean Students

Table 2 shows that, there is a meaningful relationship between total variance of 14 predictive variables and environmental literacy ($F(14, 4378) = 80.54$ $p < .01$). These variables clarified for approximately the 21% of the total variance in environmental literacy, a dependent variable. Determinants that affect environmental literacy positively in Singaporean students are "extra-curricular activities", "teacher's teaching skills" and "attitude towards school". However, the most negative determinants are the "teacher's disposition to teaching", "teacher's feedback for academic development of student" and "interest in science content knowledge".

Table 2. Regression analysis of environmental literacy of Singaporean students

Determinant	B	Std. Er.	Beta	T	P	Zero-Order	Partial
Constant	2.062	.080		25.887	.000	-	-
Extra-Curricular Activities	.140	.008	.276	18.273	.000	.356	.266
Teacher's Teaching Skills	.092	.013	.101	7.252	.000	.155	.109
Attitude toward Science	-.010	.007	-.021	-1.320	.187	-.224	-.020
Attitude towards School	.061	.015	.056	4.121	.000	.062	.062
Teacher's Feedback for Academic Development of Student	-.047	.006	-.113	-7.307	.000	-.263	-.110
Attitude of Teachers towards the student	-.003	.007	-.006	-.418	.676	.061	-.006
Interest in Science Content Knowledge	-.038	.018	-.032	-2.117	.034	-.156	-.032
Test Anxiety of Student	.035	.007	.072	5.184	.000	.108	.078
Education Support of Parents	-.018	.008	-.035	-2.407	.016	-.132	-.036
Teacher's Disposition to Teaching	-.049	.007	-.117	-7.500	.000	-.249	-.113
Teamwork	-.004	.007	-.009	-.630	.529	-.061	-.010
Class Management	-.020	.006	-.045	-3.156	.002	-.115	-.048
Socio Economic Characteristics	.008	.010	.012	.872	.383	-.022	.013
Educational Level of Parents	.007	.005	.020	1.434	.152	.063	.022

$R= 0.45$, $R^2 = 0.21$, $F_{(14, 4378)} = 80.54$, $p < .01$

According to stepwise regression analysis, the mathematical model is demonstrated below: (**Appendix 5**):

Environmental Literacy = 2.053 + .14∗(ECA) − .05∗(TDT) + .09∗(TTS) − .05∗(TFADS) + .04∗(TAS) + .06∗(ATSch) − .02∗ (CM) − .05∗(ISCK) − .02∗(ESP)

9 steps are included in the multiple regression analysis; however, 18% of 20% of the total variance in environmental literacy reveals variables in the first 3 steps. The "extra-curricular activities" that provide the highest contribution to the regression equation and the explanatory rate is 13%.

Findings related to Estonian Students

As **Table 3** presents, there is a meaningful relationship between total variance of 14 predictive variables and environmental literacy ($F(14, 4379) = 61.17$ $p < .01$). These variables clarified for approximately the 16% of the total variance in environmental literacy, a dependent variable. One of the main determinants that affect environmental literacy positively in Estonian students is "extra-curricular activities" and the other one is "teacher's teaching skills". "Teacher feedback for academic development of student" is the most important negative determinant.

Table 3. Regression analysis of environmental literacy of Estonian students

Determinant	B	Std. Er.	Beta	T	P	Zero-Order	Partial
Constant	1.793	.082		21.861	.000		
Extra-Curricular Activities	.165	.008	.302	19.733	.000	.318	.286
Teacher's Teaching Skills	.103	.011	.134	9.149	.000	.186	.137
Attitude toward Science	.040	.007	.088	5.359	.000	-.050	.081
Attitude towards School	.054	.016	.048	3.354	.001	.074	.051
Teacher's Feedback for Academic Development of Student	-.044	.007	-.098	-6.264	.000	-.213	-.094
Attitude of Teachers towards the student	.015	.008	.029	1.975	.048	.013	.030
Interest in Science Content Knowledge	.050	.018	.042	2.713	.007	-.012	.041
Test Anxiety of Student	.030	.007	.061	4.248	.000	.084	.064
Education Support of Parents	-.010	.008	-.019	-1.309	.191	-.055	-.020
Teacher's Disposition to Teaching	-.032	.007	-.072	-4.528	.000	-.167	-.068
Teamwork	-.019	.008	-.036	-2.519	.012	-.058	-.038
Class Management	.010	.006	.022	1.535	.125	.014	.023
Socio Economic Characteristics	-.022	.010	-.032	-2.246	.025	-.061	-.034
Educational Level of Parents	-.010	.007	-.019	-1.337	.181	-.027	-.020

$R = 0.41$, $R^2 = 0.16$, $F_{(14, 4370)} = 61.17$, $p < .01$

According to stepwise regression analysis, the mathematical model is demonstrated below: (**Appendix 6**):

Environmental Literacy = 1.799 + .16∗(ECA) + .11∗(TTS) − .05∗(TFADS) +.04∗(ATSci) − .03∗(TDT) + .03∗(TAS) + .05∗(ATSch) − .02∗(TW) + .05∗(ISCK) − .02∗(SEC)

There are 10 steps involved in multiple regression analysis; however, 15% of the 16% of the total variance in environmental literacy are variable in the first 4 steps. "Extra-curricular activities" are the predictor variables that provide the highest contribution to the regression equation and the explanation rate is 10%.

DISCUSSION

In the light of selected determinants, it is concluded that all three countries have a low but significant relationship between environmental literacy and variables. Although for Estonian students there seems various determinants that affect on environmental literacy, it is also seen that the total variance ratio is lower than the other two countries. Although the determinant affecting environmental literacy is few in German students, the variance rate is about the same as that of Singaporean students. It is the determinant "extra-curricular activities" that is associated with the curriculum that has the most significant positive impact on environmental literacy among all three countries' students. The determinant "extra-curricular activities" has the greatest positive impact on environmental literacy of German students. In a similar study, it is mentioned that out-of-school activities have an important effect on the students' physical success (Adeyemo, 2010). However, Sayin and Gelbal (2014) found that participation in social activities was the least important factor in the success of students. In analysing PISA 2006 data, Yildirim's (2012) identified that family characteristics

as the most important factor of the educational qualities of Turkey. In Sarier's (2016) study, the most important factors affecting the academic success of students are found to be socio-economic status, self-efficacy and motivation. On the other hand, in Farooq's et al. studies (2011), socio-economic characteristics and parents' education have a significant effect on students' overall academic achievement. Moreover, in another study, Kaya and Elster (2017a) mentioned that there is a significant relationship between EL and SEC. However, in this research, "socio-economic characteristics" determinant is not a meaningful determinant in environmental literacy in Germany and Singapore. Furthermore, "educational level of parents" determinant is not the significant determinant for the environmental literacy in three countries.

When the teacher-derived factors are examined, the factor "teacher's teaching skills" has positive and significant effect in all three countries. However, "teacher's disposition to teach" has a significant negative impact. "Teacher's feedback for academic development of student" is found to be another teacher-driven factor that has a significant impact on environmental literacy in the negative direction in all three countries. Another similar study was stated that teacher support is influential on achievement performance (Becker & Luthar, 2002). According to Akiri (2013), quality teachers produced better performing students; however, the observed differences in students' performance were statistically not significant. However, Sayin and Gelbal (2014) studied with university candidates and found that the most important factor in the success of the students was teacher competencies and the teaching strategy and method.

With the help of the "Test Anxiety of student" factor which is one of the student-derived factor, students are having a positive effect on environmental literacy. When an anxiety is at a certain level, it can have a positive effect. While the anxiety rises, it can turn into a negative effect. Since, test anxiety causes a negative effect on academic achievement in different studies (Olatoye, 2009; Rana & Mahmood, 2010; Yildirim, 2000). The other student-generated factor "attitude towards the science" has a negative impact on environmental literacy of students in both Germany and Singapore; students have a positive impact on environmental literacy in Estonia. This effect is meaningful for German and Estonian students; but it does not seem to make sense for Singaporean students. In his studies (2009, 2011), Anil used PISA 2006 data to identify students' "attitudes toward science" as one of the most predictive variables of science achievement. Another study indicates that there is a meaningful and positive relationship between attitudes towards science and technology, and academic achievement (Akpınar et al., 2009; Ali, Iqbal, & Akhtar, 2015). Besides, it is stated that there is a strong relationship between attitude towards science and achievement (Craker, 2006). Similar results have been obtained in studies conducted in different interdisciplinary fields. In one of these, it is seen that there is a relationship between the attitude towards the course and mathematics success (Savas, Tas, & Duru, 2010).

Another factor which is "attitude towards school", has a positive impact on the environmental literacy of students from all three countries. This effect has been achieved for Estonian and Singaporean students but it is meaningless for German students. In Moè, Pazzaglia, Tressoldi and Toso's work (2009), they point out that the relationship between emotional motivation variables and academic achievement is the role of the attitude toward the arrow. Moreover, Verešová and Malá (2016) mention that 'the attitude toward school and learning' is an important predictor of achievement. Therefore, the more positive is 'the attitude towards school and learning of students, the more positive is academic achievement at the end of the school year. Another study reveals that attitudes toward school influence achievement, however, only indirectly (Abu-Hilal, 2000).

CONCLUSIONS AND RECOMMENDATIONS

The findings demonstrate the importance of "extra-curricular activities" to train more qualified environmental literate individuals. Therefore, more extra-curricular activities such as stimulating natural phenomena in computer programs, participation in science clubs especially ecology organizations, field trips and excursions that promote the awareness and the connectedness to the nature and the environment should be included in formal education. In addition, these activities should support formal education and be implemented and encouraged in a planned manner as a complement to each other.

In addition, support should be provided for the development of teacher training skills for science teachers and teacher candidates. Examples for skills and competences that should be trained are how to give feedback for the academic development of the student, how teamwork should be implemented, and what to look for an effective classroom management. In addition, practical environmental education could be offered through in-service and pre-service education. In this way, teachers' tendency (teacher's disposition to teach) towards teaching can be improved. In this process, teachers and teacher candidates should be encouraged to use a

constructivism approach in teaching and learning and ensure an effective students' participation in this process.

On the other hand, the reasons for the positive effects of the attitudes of students in Estonia towards the school, science and science content knowledge to environmental literacy should be investigated in more detail. Science education applications should be investigated which lead to positive attitudes towards students in education. In this area, Estonia's education system can lead to improved environmental literacy for students by identifying good examples of the science education system in particular.

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No potential conflict of interest was reported by the authors.

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APPENDIX 1

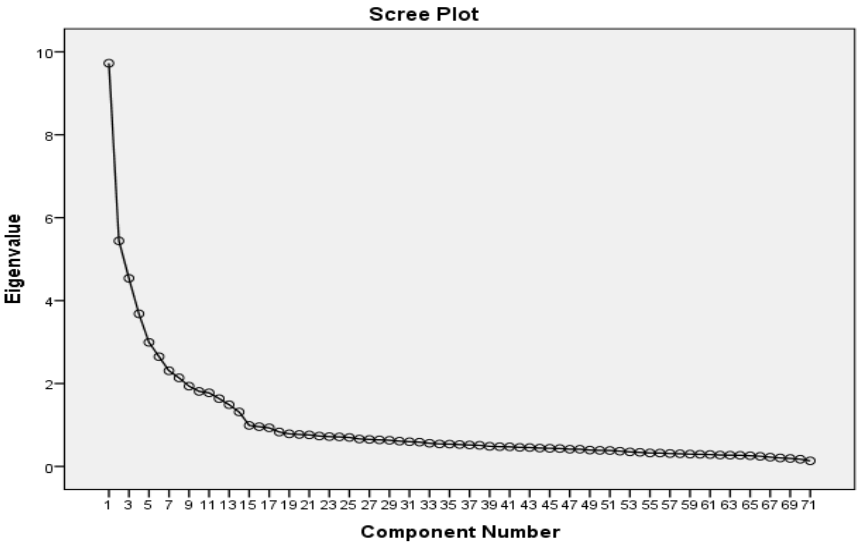
Kaiser-Meyer-Olkin and Bartlett's Test of Sphericity Results

Kaiser-Meyer-Olkin Value		.90
Bartlett's Test Value		104.010,774
		2485
	p	.00

* p<.01

APPENDIX 2

Graphic of Eigenvalues



APPENDIX 3

P-P Plot of Regression

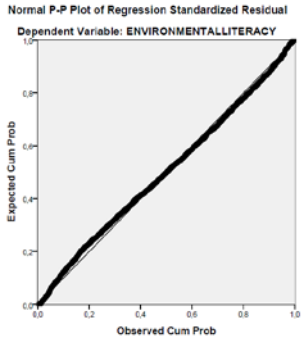


Figure A: P-P Plot of Regression (Germany)

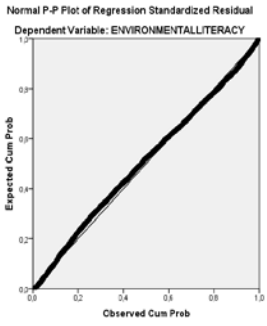


Figure B: P-P Plot of Regression (Singapore)

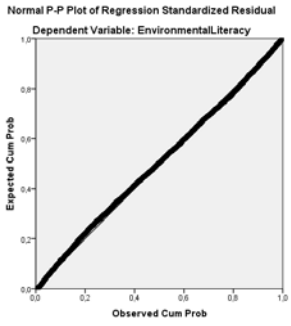


Figure C: P-P Plot of Regression (Estonia)

APPENDIX 4

Stepwise Regression Analysis of Enviromental Literacy for Germany

Model	Factor	B	Std. Er.	Beta	t	p	R	R^2
1	(Constant)	1.881	.042		44.655	.000	.315	.099
	ECA	.192	.012	.315	16.049	.000		
2	(Constant)	2.222	.049		44.999	.000	.393	.154
	ECA	.169	.012	.279	14.461	.000		
	TDT	-.111	.009	-.237	-12.267	.000		
3	(Constant)	1.856	.063		29.687	.000	.429	.184
	ECA	.161	.012	.265	13.957	.000		
	TDT	-.087	.009	-.186	-9.449	.000		
	TTS	.148	.016	.181	9.247	.000		
4	(Constant)	1.979	.068		29.202	.000	.437	.191
	ECA	.150	.012	.246	12.719	.000		
	TDT	-.073	.010	-.156	-7.550	.000		
	TTS	.136	.016	.166	8.381	.000		
	TFADS	-.049	.011	-.096	-4.585	.000		
5	(Constant)	2.129	.076		28.058	.000	.445	.198
	ECA	.126	.013	.208	9.817	.000		
	TDT	-.065	.010	-.138	-6.549	.000		
	TTS	.135	.016	.165	8.366	.000		
	TFADS	-.050	.011	-.099	-4.728	.000		
	ATSci	-.035	.008	-.092	-4.333	.000		
6	(Constant)	2.055	.079		26.110	.000	.449	.202
	ECA	.125	.013	.205	9.687	.000		
	TDT	-.063	.010	-.135	-6.401	.000		
	TTS	.135	.016	.166	8.411	.000		
	TFADS	-.051	.011	-.100	-4.780	.000		
	ATSci	-.032	.008	-.084	-3.957	.000		
	TAS	.031	.009	.065	3.485	.001		
7	(Constant)	2.166	.089		24.435	.000	.452	.204
	ECA	.125	.013	.205	9.714	.000		
	TDT	-.062	.010	-.133	-6.339	.000		
	TTS	.131	.016	.160	8.082	.000		
	TFADS	-.049	.011	-.097	-4.647	.000		
	ATSci	-.031	.008	-.083	-3.906	.000		
	TAS	.030	.009	.064	3.392	.001		
	ESP	-.030	.011	-.051	-2.716	.007		

APPENDIX 5

Stepwise Regression Analysis of Environmental Literacy for Singapore

Model	Factor	B	Std. Er.	Beta	t	p	R	R^2
1	(Constant)	1.975	.024		82.194	.000	.356	.127
	ECA	.181	.007	.356	25.246	.000		
2	(Constant)	2.258	.030		74.248	.000	.409	.167
	ECA	.167	.007	.328	23.605	.000		
	TDT	-.086	.006	-.204	-14.657	.000		
3	(Constant)	2.027	.042		48.276	.000	.423	.179
	ECA	.166	.007	.326	23.621	.000		
	TDT	-.078	.006	-.185	-13.234	.000		
	TTS	.100	.013	.110	7.933	.000		
4	(Constant)	2.128	.044		48.662	.000	.436	.190
	ECA	.154	.007	.303	21.531	.000		
	TDT	-.058	.006	-.139	-9.131	.000		
	TTS	.099	.013	.109	7.893	.000		
	TFADS	-.049	.006	-.118	-7.682	.000		
5	(Constant)	2.035	.047		43.220	.000	.442	.195
	ECA	.151	.007	.298	21.240	.000		
	TDT	-.058	.006	-.137	-9.067	.000		
	TTS	.097	.013	.106	7.715	.000		
	TFADS	-.049	.006	-.117	-7.612	.000		
	TAS	.035	.007	.071	5.208	.000		
6	(Constant)	1.877	.061		30.700	.000	.445	.198
	ECA	.149	.007	.294	20.957	.000		
	TDT	-.058	.006	-.137	-9.051	.000		
	TTS	.097	.012	.107	7.770	.000		
	TFADS	-.049	.006	-.117	-7.654	.000		
	TAS	.038	.007	.078	5.709	.000		
	ATSch	.060	.015	.055	4.029	.000		
7	(Constant)	1.942	.063		30.731	.000	.448	.201
	ECA	.149	.007	.294	20.988	.000		
	TDT	-.054	.006	-.127	-8.313	.000		
	TTS	.095	.012	.105	7.643	.000		
	TFADS	-.048	.006	-.116	-7.594	.000		
	TAS	.035	.007	.072	5.265	.000		
	ATSch	.062	.015	.058	4.210	.000		
	CM	-.024	.006	-.055	-3.955	.000		
8	(Constant)	2.001	.066		30.271	.000	.450	.203
	ECA	.144	.007	.284	19.763	.000		
	TDT	-.052	.006	-.124	-8.130	.000		
	TTS	.096	.012	.105	7.680	.000		
	TFADS	-.048	.006	-.116	-7.585	.000		
	TAS	.035	.007	.071	5.145	.000		
	ATSch	.060	.015	.055	4.051	.000		
	CM	-.023	.006	-.051	-3.642	.000		
	ISCK	-.050	.017	-.042	-3.013	.003		
9	(Constant)	2.053	.069		29.854	.000	.452	.204
	ECA	.143	.007	.283	19.628	.000		
	TDT	-.051	.006	-.120	-7.789	.000		
	TTS	.093	.013	.102	7.424	.000		
	TFADS	-.047	.006	-.113	-7.421	.000		
	TAS	.035	.007	.072	5.219	.000		
	ATSch	.062	.015	.057	4.176	.000		
	CM	-.021	.006	-.047	-3.369	.001		
	ISCK	-.046	.017	-.039	-2.747	.006		
	ESP	-.020	.007	-.038	-2.733	.006		

APPENDIX 6

Stepwise Regression Analysis of Environmental Literacy for Estonia

Model	Factor	B	Std. Er.	Beta	t	p	R	R^2
1	(Constant)	2,069	,026		78,718	,000	,318	,101
	ECA	,174	,008	,318	22,199	,000		
2	(Constant)	1,809	,034		53,625	,000	,360	,130
	ECA	,169	,008	,309	21,879	,000		
	TTS	,130	,011	,169	12,000	,000		
3	(Constant)	1,993	,040		49,584	,000	,378	,143
	ECA	,153	,008	,280	19,409	,000		
	TTS	,117	,011	,152	10,752	,000		
	TFADS	-,054	,006	-,121	-8,278	,000		
4	(Constant)	1,837	,048		38,219	,000	,387	,150
	ECA	,167	,008	,306	20,342	,000		
	TTS	,121	,011	,158	11,174	,000		
	TFADS	-,057	,006	-,129	-8,847	,000		
	ATSci	,039	,007	,087	5,853	,000		
5	(Constant)	1,899	,050		38,032	,000	,392	,154
	ECA	,168	,008	,307	20,482	,000		
	TTS	,111	,011	,145	10,043	,000		
	TFADS	-,046	,007	-,104	-6,643	,000		
	ATSci	,044	,007	,099	6,554	,000		
	TDT	-,032	,007	-,071	-4,467	,000		
6	(Constant)	1,839	,052		35,280	,000	,396	,157
	ECA	,167	,008	,305	20,374	,000		
	TTS	,108	,011	,140	9,695	,000		
	TFADS	-,046	,007	-,103	-6,606	,000		
	ATSci	,047	,007	,105	6,967	,000		
	TDT	-,033	,007	-,073	-4,600	,000		
	TAS	,027	,007	,056	3,985	,000		
7	(Constant)	1,706	,067		25,347	,000	,398	,158
	ECA	,163	,008	,299	19,790	,000		
	TTS	,108	,011	,141	9,775	,000		
	TFADS	-,045	,007	-,102	-6,538	,000		
	ATSci	,047	,007	,105	6,978	,000		
	TDT	-,033	,007	-,073	-4,621	,000		
	TAS	,031	,007	,063	4,437	,000		
	ATSch	,050	,016	,044	3,108	,002		
8	(Constant)	1,754	,070		25,177	,000	,400	,160
	ECA	,163	,008	,299	19,798	,000		
	TTS	,107	,011	,140	9,672	,000		
	TFADS	-,044	,007	-,099	-6,341	,000		
	ATSci	,047	,007	,105	6,969	,000		
	TDT	-,032	,007	-,072	-4,533	,000		
	TAS	,032	,007	,066	4,624	,000		
	ATSch	,052	,016	,045	3,203	,001		
	TW	-,020	,007	-,037	-2,625	,009		
9	(Constant)	1,733	,070		24,737	,000	,401	,161
	ECA	,165	,008	,301	19,933	,000		
	TTS	,107	,011	,140	9,673	,000		
	TFADS	-,044	,007	-,099	-6,366	,000		
	ATSci	,040	,007	,089	5,438	,000		
	TDT	-,033	,007	-,073	-4,622	,000		
	TAS	,032	,007	,065	4,576	,000		
	ATSch	,052	,016	,046	3,215	,001		
	TW	-,020	,007	-,038	-2,704	,007		
	ISCK	,049	,018	,041	2,673	,008		
10	(Constant)	1,799	,076		23,628	,000	,403	,162
	ECA	,164	,008	,300	19,836	,000		
	TTS	,106	,011	,138	9,590	,000		
	TFADS	-,045	,007	-,100	-6,421	,000		
	ATSci	,039	,007	,087	5,371	,000		
	TDT	-,032	,007	-,071	-4,501	,000		
	TAS	,031	,007	,064	4,496	,000		
	ATSch	,051	,016	,045	3,190	,001		
	TW	-,019	,007	-,036	-2,588	,010		
	ISCK	,051	,018	,043	2,771	,006		
	SEC	-,021	,010	-,031	-2,203	,028		