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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 the 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, it was tried to determine the main factors 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. 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 Kaya and Elster (2017b). It was also classified by the researchers to determine the basic determinants affecting environmental literacy. In the light of the selected determinants, it was concluded that in all three countries there was a low but significant relationship between environmental literacy and the determinants affecting the environmental literacy. In Estonian case, there were various factors affecting environmental literacy furthermore, the total variance ratio was lower than the other two countries. In German case, the determinants affecting environmental literacy were few and the variance rate was about the same as that of Singaporean. "Extra curricula activities" was the determinant which had the most significant positive impact on environmental literacy among students in all three countries.

Keywords: *Comparative Study, Science Education, Environmental Literacy, Literacy*

1. 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.

1.1 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 [8]. Nevertheless, after nearly twenty years (in the 1990s), the concept of environmental literacy witnessed the improvement of environmental education [4]. In fact, although there is no universal definition [3,6], researchers have divided environmental literacy into various categories. In one of these studies, environmental literacy has four major components: knowledges, skills, affect and behaviour [9]. In other study, it is mentioned that environmental literacy (EL) has five categories of concepts including; awareness, knowledge, attitude, skills, and participation [10]. According to PISA results, the categories of environmental literacy involve awareness, responsibility and optimism towards the environment [1] as well as the development of environmental behaviour [2].

1.2. Purpose of Study

A good formal education should be assessed through including the performances of the students [5]. 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

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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.

1.3. 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. The reason for comparing the environmental literacy of Germany students to Singaporean and Estonian students is that when the PISA 2015 data are analyzed the highest average among participants in science literacy was in Singapore and Estonia had highest average among the participants of the European countries [7]. For this reason, these three countries were compared with environmental literacy. Within the scope of this aim, answers to the following questions were sought:

1. 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?
2. 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 among the countries?

2. Research Methods and Design

The relational model, which is one of the quantitative research approaches, has been adopted in this study. As a 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 6.500 German students, 6.115 Singaporean students and 5.587 Estonian students. PISA 2015 data obtained on the internet from the official PISA web site (http://www.pisa.oecd.org) are used.

2.1. Instruments

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. 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.
Standard regression analysis and stepwise regression analysis were tested by the measurement of the variance factors affecting environmental literacy. Before the regression analysis, it was tested some assumptions (such as normality, linearity, multi-collinearity, autocorrelation etc.) to determine whether or not to perform regression analysis.

3. Results and Comments

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-Curricula 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	-,049	,025	-,042	1,952	,051	-,178	-,040

Knowledge							
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							

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. 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. According to stepwise regression analysis, the mathematical model below:

Environmental Literacy = 2,166 + ,13*(ECA) - ,06*(TDT) + ,13*(TTS) -,05*(TFADS) - ,03*(ATSci) + ,03*(TAS) - ,03*(ESP)

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-Curricula 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							

Table 2 shows the results of the regression analysis of environmental literacy of students in Singapore. 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, the dependent variable. Determinants that affect environmental literacy positively of Singaporean students are "extra-curricula 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". According to stepwise regression analysis, the mathematical model is demonstrated below:

Environmental Literacy = 2,053 + ,14*(ECA) - ,05*(TDT) + ,09*(TTS) - ,05*(TFADS) + ,04*(TAS) + ,06*(ATSch) - ,02* (CM) - ,05*(ISCK) -,02*(ESP)

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-Curricula 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
$R= 0.41$, $R^2 = 0.16$, $F_{(14, 4370)} = 61,17$, $p < .01$							

Table 3 presents the results for Estonian students. 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, the dependent variable. One of the main determinants that affect environmental literacy positively in Estonian students is "extra curricula activities" and the other one is "teacher's teaching skills". "Teacher feedback for academic development of student" is the most important negative determinant. According to stepwise regression analysis, the mathematical model is demonstrated below:

Environmental Literacy = 1,799 + ,16*(ECA) + ,11*(TTS) - ,05*(TFADS) +,04*(ATSci) - ,03*(TDT) + ,03*(TAS) + ,05*(ATSch) - ,02*(TW) + ,05*(ISCK) - ,02*(SEC)

3. 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.

References

[1] Kaya, V. H. and Elster, D. (2017a). German Students' Environmental Literacy as a Starting Point for Science Teacher Education, *International Teacher Education and Accreditation Congress Abstract Book,* Paper 113- 114.

[2] Kaya, V.H. and Elster, D. (2017b). Change in the Environmental Literacy of German Students in Science Education between 2006 and 2015, *The Turkish Online Journal of Educational Technology, Special Issue for INTE 2017*, 505-524.

[3] Loubser, C.P., Swanepoel, C.H. and Chacko, C. P. C. (2001). Concept Formulation for Environmental Literacy, *South African Journal of Education, 21 (4).*

[4] McBeth, W. and Volk, T. L. (2010). The National Environmental Literacy Project: A Baseline Study of Middle Grade Students in the United States, *The Journal of Environmental Education, 41(1),* 55–67.

[5] Modupe, O. D. (2012). A Dummy Variable Regression on Students' Academic Performance, *Transnational Journal of Science and Technology, 2(6),* 47-54.

[6] Morrone, M., Mancl, K. and Carr, K. (2001) Development of a Metric to Test Group Differences in Ecological Knowledge as One Component of Environmental Literacy, *The Journal of Environmental Education,* 32:4, 33-42.

[7] OECD. (2016). PISA 2015 PISA Results in Focus, Retrieved 29.07. 2017, 09.36 from https://www.oecd.org/pisa/pisa-2015-results-in-focus.pdf.

[8] Ozturk, G., Tuzun, Ö.Y. and Teksoz, G. (2013). Exploring Environmental Literacy Through Demographic Variables, *Elementary Education Online, 12(4),* 926-937.

[9] Roth, C. E. (1992). *Environmental Literacy: Its roots, evolution and directions in the 1990s.,* ERIC Clearinghouse for Science, Mathematics, and Environmental Education, Columbus, Ohio.

[10] Wisconsin Department of Public Administration. (1991). *Environmental Education. A Guide to CurriculumPlanning (Authors: Engleson, D.C. and Yockers, D.H.)*, Wisconsin State Dept. of Public Instruction,Madison.