

Research Article**Dimensions Affecting Environmental Literacy, and Environmental Perceptions Influencing Science Literacy***Volkan Hasan KAYA¹  Doris ELSTER² **Abstract**

One of the main aims of this paper is to determine the dimensions (effects of family, teacher, student, and teaching) that influence the environmental literacy. Moreover, another purpose is to determine the effects of environmental perceptions (environmental awareness, environmental responsibility and environmental optimism) on science literacy of fifteen-years-old students in Germany. The sample consisted of 6.500 German students. The relational model, which is one of the quantitative research approaches, has been adopted in this study. The results show that ‘the dimension of the teacher’, one of the dimensions included in the first model, has the most negatively effect on environmental literacy; but, the dimension of ‘effect of teaching’ has the positively effect on environmental literacy. In addition, in the second model, it is obtained results that students of environmental awareness and optimism have a positive effect on the science literacy; but environmental responsibility has a negative effect on it. For this reason, while developing environment-related curriculums, it should be supported students to gain more responsible behaviors towards the environment. Enhancing the environmental responsibility of the students might contribute to both environmental literacy and science literacy.

Keywords: Environmental literacy, science literacy, PISA, environmental perceptions

1. INTRODUCTION

The main purpose of this study is to elucidate the reflection of education for sustainable development (ESD) applied in Germany between 2005 and 2014 on both the environmental and science literacy (SL). Through ESD, it is stated that when students obtain knowledge about the environment, they might be critical thinkers and develop socially critical learning and problem-solving skills (Peden, 2008). This education was planned to make both national and international assessments on environmental literacy (Hollweg, Taylor, Bybee, Marcinkowski, McBeth & Zoido, 2011). To increase the quality of sustainable development in the future, outcomes of the environmental literacy especially environmental perceptions has an important role. Therefore, this study aims to determine both the dimensions (family, teacher, learner and teaching) that influence the environmental literacy and the effect of environmental perceptions on SL.

1.1. The Education for Sustainable Development

Education for sustainable development have a more significant role in the future social transformation for people to survive their lives (Peters & Gonzalez-Gaudiano, 2008). The education for sustainable development is a way to be pursued for sustainable future (Tabucanon, 2010). In 2005, the UNESCO launched its Decade of Education for Sustainable Development (2005-2014) (UNESCO,

Received Date: 12/01/2019

Accepted Date: 05/03/2019

***To cite this article:** Kaya, V.H. & Elster, D. (2019). Study on the main dimensions affecting environmental literacy, and environmental perceptions influencing science literacy. *International e-Journal of Educational Studies (IEJES)*, 3 (6), 70-77. DOI: 10.31458/iej.512201

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2005b). In this decade, educational institutions in Germany increased their efforts to educate students for a more sustainable future (Kaya & Elster, 2017a). Through education for sustainable development, individuals benefit from education and gain the values and behaviors that are necessary in their lives for a more qualified social transformation and sustainable future (UNESCO, 2005a). Furthermore, education for sustainable development focuses on the competencies required to transform social relations, economics and the management of natural resources (Dannenberg & Grapentin, 2016). Thus, education for sustainable development, that integrates economic growth, social development, and environmental protection, is aimed at improving the quality of life of individuals, both now and in the future (UNESCO, 2005b).

1.2. Science and Environmental Literacy

SL is a one of some main concepts of the science education (SE). According to National Science Education Standards, “the scientific literate individual can ask, find, or determine answers to questions raised by curiosity about daily life. The individual has the skill to describe, explain, and predict natural phenomena (NRC, 1996)”. This concept has continued to be relevant in SE because of its openness to change and development.

On the other hand, environmental literacy is a more specific concept than SL. According to PISA results, environmental literacy has three categories as responsibility and optimism towards the environment (Kaya & Elster, 2017a), and the development of environmental behavior (Kaya & Elster, 2017b). Moreover, environmental perceptions are paramount elements of environmental literacy. It is stated that there is a positive correlation between the ‘responsibility and awareness towards the environment’ in the definition of environmental literacy and ‘optimism towards the environment’ (Kaya & Elster, 2018a). To educate more optimistic students for a more sustainable future and development, both the science and the environment literacy of students should be developed. For this reason, the influence and interrelationship of these two concepts in SE should be taken into consideration.

1.3. Purpose of the Research

Although EE has become more and more significant (Aslan-Efe, 2015), traditional approaches to EE seem to be ineffectual in overcoming the environmental problems (Çimen & Yılmaz, 2014). Therefore, education for sustainable development, which is important for a sustainable future and carries the traces of transformative education, has been implemented between 2005 and 2014. Education for sustainable development assures the sustainable life opportunity, aspirations and futures for youth (Pavlova, 2013). Moreover, economic development is the basis of human development in education for sustainable development (Tanriverdi, 2009). Therefore, the importance of environment-oriented education for sustainable development is expected to increase in the future. Thus, outcomes of the education for sustainable development (between 2005 to 2014) should be assessed. Moreover, the disclosure of the effect of environmental perceptions on the SL can lead to a more qualified implementation of education for sustainable development in the future.

1.4. Design of Research

For a more sustainable future and development, more qualified environmentally literate individuals are needed with the contribution of SE. For this reason, it is necessary to determine the dimensions that affect ‘education for sustainable development’ through environmental literacy. Moreover, not only schools including teachers and teaching are responsible for the educating of more qualified individuals, but also the students themselves, and their families are responsible for more sensitive, responsible, and aware individuals in respect to the environment. Focusing on these aspects might also allow to promote more productive solutions for a sustainable development and future.

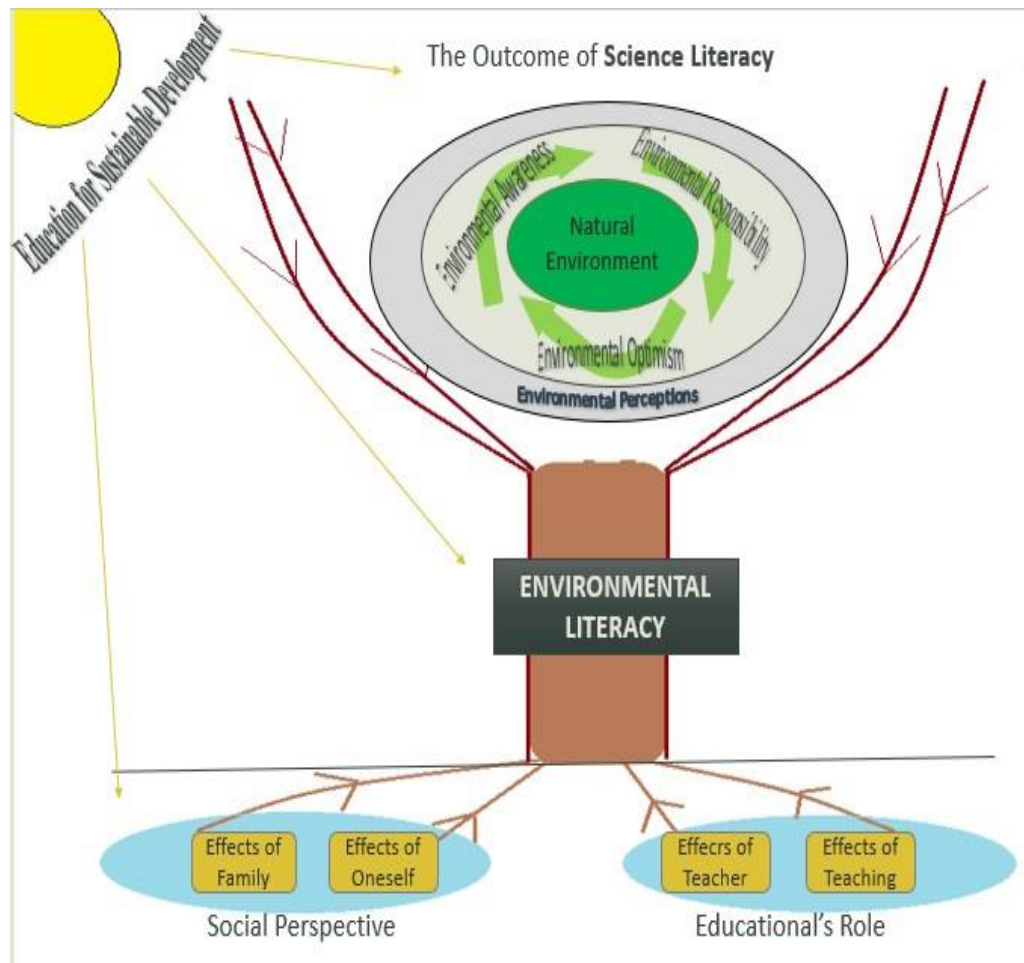


Figure 1. Design of research

The development of literacy, especially the development of environmental literacy, is like the development of a seed. There are several factors that affect the development of the seed as well as the factors (such as family, teacher, learner and teaching etc...) that affect the development of environmental literacy. The most environment constituents that are effective on plants should be considered together, otherwise, the deficiency of one fundamental component can affect the development of the plant (Easton & Glauer, 2015). Similarly, the environmental factors that affect the quality of the learner should be taken into the consideration together. A more qualified recommendation can be put on this view. In general, the essential components influencing student quality are the learning social environment, and the formal education in which it is being trained. Two important educators in the life of a learner are their families and their teachers (DCSF, 2009). Both have an important role at each stage of education (Scottish Executive, 2006). Moreover, the science teaching process in the school, and the student himself have an essential effect on the quality of the learners. It is also important to assess whether these paramount dimensions have a desired level of influence on the education for sustainable development. Consequently, in this study, the effects of the family, the learner, the science teacher, and teaching on the education for the sustainable development have been disclosed through environmental literacy.

On the other hand, in the light of the obtained outcome of the education for sustainable education at the end of the formal education, it is necessary to reveal the effects of environmental perceptions on the SL. These outcomes would mention whether the curriculum has helped to support the pupils with the competencies, values, citizenship responsibilities in the curricular targets (Stabback, 2016). By this means, for more sustainable development and future, researchers, policymakers, educators and teachers receive effective feedback on how to improve and teach the next generation SE. Curriculum development, teaching, assessment and learning environments should be permanently focused on educational outcomes (European Centre for the Development of Vocational Training, 2012; p. 19). Therefore, the outcome of the EDS on the SE is also the paramount element of

the development of the qualified students. Education, especially ‘education for Sustainable Development’, is not only about being the environmental literate individual (Nayar, 2013); it also about being the successful individual in SE. In this study, the outcomes of EDS on SE were examined through SL and recommendations about the obtained results were shared in the part of the implications and recommendations.

1.5. Research Questions

In this study, one of the main aims of this paper is to determine the dimensions (effects of family, teacher, student, and teaching) that influence the environmental literacy. Moreover, another aim is to analyse the effects of environmental perceptions on SE through SL. In these regards the research questions are:

- What are the dimensions (effects of family, teacher, student, and teaching) influencing the Environmental Literacy (EL) of the German students?
- How much of the explained variance of the Environmental Literacy averages is explained by the dimensions covered in this research?
- What are the environmental perceptions (environmental awareness, environmental responsibility and environmental optimism) influencing the SL of the German students?
- How much of the explained variance of SL averages is explained by the environmental perceptions covered in this research?

2. METHOD

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

2.1. 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 dimensions (effects of family, teacher, student, and teaching) influencing the Environmental Literacy (EL) and the dimensions that related environmental perceptions (environmental awareness, environmental responsibility and environmental optimism) influencing the SL. This empirical study is designed to provide a more successful development of SE for a more sustainable future.

2.2. Sampling

In this study, the universe was 15-years-old German students. The PISA sample selection was conducted randomly by applying the two-stage stratified sampling method (Albayrak-Sarı, 2015). The sample consisted of 6.500 German students. The data obtained with the participation of students from Germany involved PISA 2015 data. It was obtained on the internet from the official PISA web site (<http://www.pisa.oecd.org>).

2.3. Measures and Data Tools

Two regression models are created in this study. The main purpose of the first regression model is to determine the dimensions (effects of family, teacher, student, and teaching) influencing the Environmental Literacy (EL) and to calculate the explained variance of the Environmental Literacy averages. Researchers used *Environmental Literacy Scale* developed by Kaya and Elster (2017b) to calculate students' scores in the 1st regression model. The environmental literacy scores of the students were considered as dependent variables. Moreover, the 71 items selected from the student questionnaires in the PISA data were classified categories by Kaya and Elster (2018b) as 14 main factors. In this study, these factors are categorized on 4 main dimensions (effects of family, teacher, student, and teaching) as the independent variables.

The goal of the second regression model is to determine the environmental perceptions (environmental awareness, environmental responsibility and environmental optimism) influencing the SL and to calculate the explained variance of SL averages. The SL scores were obtained from the

PISA 2015 data in the 2nd regression model. The SL scores of the students were considered as dependent variables. Furthermore, the 20 items selected from the student questionnaires in the PISA data were classified on 3 main dimensions that related to environmental perceptions (environmental awareness, environmental responsibility and environmental optimism) as the independent variables.

2.4. Data Analysis

The multiple regression analysis which are standard regression analysis and stepwise regression analysis were tested by the measurement of the variance factors affecting both environmental literacy and SL. Before the regression analysis, it was tested some assumptions (such as normality, linearity, multi-collinearity, autocorrelation etc.) by using graph images and some statistical analysis via SPSS software to determine whether or not to perform regression analysis.

Before regression analysis, the multiple linear regression model should provide some assumptions. In this study, it is also examined that the correlation between independent variables and dependent variable are not higher than 0.80. Moreover, it is seen that the maximum value of The Variance Inflation Factor value is between 1.01 and 1.30. The Durbin-Watson coefficient is seen that the model established for model of environmental literacy is 1.95, while the model established for SL is 1.94. P-P Plot images show that the regression analysis is normally distributed.

3. RESULTS

3.1. Results on dimensions affecting the Environmental Literacy

Table 1. Regression analysis on the main dimensions on the environmental literacy

Determinant	B	Std. Er.	Beta	T	P	Zero-Order	Partial
Constant	2,982	,102	-	29,372	,000	-	-
Effect of Family	-,065	,019	-,07	-3,383	,000	-,048	-,070
Effect of Teacher	-,199	,024	-,17	-8,295	,000	-,191	-,169
Effect of Oneself	-,102	,023	-,09	-4,523	,000	-,149	-,093
Effect of Teaching	,127	,016	,16	7,916	,001	,176	,162

R= 0.28, R² = 0.08, F_(4,2329) = 48,84, p < .01

As shown in Table 1, it was found that there is a meaningful relationship between total variance of 4 predictive variables and environmental literacy ($F(4, 2329) = 48,84$ p < .01). These variables clarified for approximately the 8% of the total variance in environmental literacy, the dependent variable.

Table 2. Stepwise regression analysis on the main dimensions on the environmental literacy

Model	Determinant	B	Std. Er.	Beta	t	P	R	R ²
1	(Constant)	3,045	,053	-	57,079	,000		
	Effect of Teacher	-,226	,024	-,19	-9,37	,000	,191	,036
2	(Constant)	2,599	,075	-	34,851	,000		
	Effect of Teacher	-,219	,024	-,18	-9,184	,000	,255	,065
3	Effect of Teaching	,133	,016	,17	8,439	,000		
	(Constant)	2,807	,088	-	32,037	,000		
	Effect of Teacher	-,200	,024	-,17	-8,310	,000	,270	,073
4	Effect of Teaching	,121	,016	,15	7,576	,000		
	Effect of Oneself	-,101	,023	-,09	-4,477	,000		
	(Constant)	2,982	,102	-	29,372	,000		
	Effect of Teacher	-,199	,024	-,17	-8,295	,000		
4	Effect of Teaching	,127	,016	,16	7,916	,000	,278	,077
	Effect of Oneself	-,102	,023	-,09	-4,523	,000		
	Effect of Family	-,065	,019	-,07	-3,383	,000		

According to stepwise regression analysis, the mathematical model was as below (Table 2):
 $Environmental\ Literacy = 2,982 - ,20*(Effect\ of\ Teacher) + ,13*(Effect\ of\ Teaching) - ,10*(Effect\ of\ Oneself) - ,07*(Effect\ of\ Family)$

The main dimension negatively influencing environmental literacy was “teacher”; the “teaching” was the most positive dimension.

3.2. Results on Environmental Perceptions on Science Literacy

Table 3. Regression analysis on the effect of environmental perceptions on SL

Determinant	B	Std. Er.	Beta	t	P	Zero-Order	Partial
Constant	415,665	13,829	-	30,058	,000	-	-
Environmental Awareness	51,630	2,859	,347	18,061	,000	,440	,326
Environmental Optimism	12,778	3,580	,061	3,569	,000	,106	,068
Environmental Responsibility	-26,120	2,673	,186	-9,773	,000	-,342	-,184

R= 0.47, R² = 0.22, F_(3,2729) = 261,57, p < .01

As shown in Table 3, it was found that there is a meaningful relationship between total variance of 3 predictive variables and SL ($F(3, 2729) = 261,57$ p < .01). These variables clarified for approximately the 22% of the total variance in SL, the dependent variable.

Table 4. Stepwise regression analysis on the effect of environmental perceptions on SL

Model	Determinant	B	Std. Er.	Beta	t	P	R	R ²
1	(Constant)	348,17	7,52		46,304	,000		
	Environmental Awareness	65,50	2,55	,440	25,664	,000	,440	,194
2	(Constant)	439,27	12,17		36,091	,000		
	Environmental Awareness	53,43	2,82	,359	18,946	,000	,468	,219
3	Environmental Responsibility	25,11	2,66	-,179	-9,428	,000		
	(Constant)	415,67	13,83		30,058	,000		
	Environmental Awareness	51,63	2,86	,347	18,061	,000	,472	,223
	Environmental Responsibility	-26,12	2,67	,186	-9,773	,000		
	Environmental Optimism	12,78	3,58	,061	3,569	,000		

According to stepwise regression analysis, the mathematical model was as below (Table 4):
 $Science\ Literacy = 415,67 + 51,63*(Environmental\ Awareness) - 26,12*(Environmental\ Responsibility) + 12,78*(Environmental\ Optimism)$

The main factor positively influencing SL were “environmental awareness” and “environmental optimism”; the “environmental responsibility” was the negative affect.

4. DISCUSSION, IMPLICATIONS AND RECOMMENDATIONS

The results show that while the independent variables (effect of teacher, teaching, oneself and family) can be explained between approximately 8% of the total variance of the first model in environmental literacy, independent variables (environmental awareness, environmental responsibility, environmental optimism) can be explained between approximately 22% of the total variance of the second model in SL.

It is seen that the dimension that is related to the teacher has the most negatively effect on environmental literacy. Another similar study is stated that although the factor “teacher’s teaching skills” has positive and significant effect on environmental literacy, the factors “teacher’s disposition to teach” and “teacher’s feedback for academic development of student” have a significant impact on environmental literacy in the negative direction in Estonia, Germany and Singapore (Kaya & Elster,

2018b). For this reason, teachers especially in the field of science should be encouraged to develop their competencies, especially their skills, dispositions to teaching, attitudes towards students during the pre-service and in-service training. Furthermore, they should also take over responsibility of their self-development to contribute to their professional development realistically (Kaya & Godek, 2016). On the other hand, the dimension of teaching has the positively effect on environmental literacy. Therefore, teacher training should provide opportunities for teacher candidates to develop their teaching skills.

It is seen that social perspectives (individuals themselves and their families) have a negatively effect on environmental literacy. Another study shows that 'attitude towards science' seems to have a positive effect on science literacy although 'parents' educational level' seems to have a negative effect on science literacy in Germany, Korea, and Turkey (Kaya, Godek, Elster & Polat, 2019). Moreover, 'socio-economic characteristics' and parents' education have a significant effect on students' academic achievement (Farooq's et al., 2011). For this reason, both the students and their families should be supported for the quality of the education. For example, governments should pay more attention to public education. Experts should give seminars on how parents might support their children both personally and academically. On the other hand, it is also necessary to increase students' attitudes towards school and science. For instance, more extra-curricular activities such as computer programs and field trips should be included in formal training (Kaya & Elster, 2018b).

In addition, environmental awareness and optimism have a positive effect on the science achievement; but environmental responsibility has a negative effect on it. For this reason, while developing environment-related curricula, it should be supported to gain more responsible behaviors towards the environment. Eventually, enhancing the environmental responsibility of the students might contribute to both environmental literacy and SL.

5. REFERENCES

- Albayrak-Sarı, A. (2015). Using structural equation modeling to investigate students' reading comprehension skills, *Elementary Education Online*, 14(2), 511-521.
- Aslan-Efe, H. (2015). The effects of animation supported environmental education on achievement, retention of ecology and environmental attitude. *Journal of Computer and Education Research*, 3 (5), 130-143.
- Çimen, O. & Yılmaz, M. (2014). The influence of transformative learning based environmental education on preservice biology teachers' perception of environmental problems. *Bartın University Journal of Faculty of Education*, 3 (1), 339-359.
- Dannenberg, S. & Grapentin, T. (2016). Education for sustainable development - learning for transformation the example of Germany. *Journal of Futures Studies*, 20(3), 7-20,
- Department for Children, Schools and Families (2009). *The impact of parental involvement on children's education*. London: DCSF.
- Easton, J. & Glauer, D. (2015). *What makes plants grow? in book: 4-h plant connections curriculum*. 4-H Youth Development Department, UF/IFAS Extension, Gainesville.
- European Centre for the Development of Vocational Training. (2012). *Curriculum reform in europe, the impact of learning outcomes*, European Centre for the Development of Vocational Training, Retrieved 02.02.2018 from: file:///C:/Users/Pc/Downloads/5529_en.pdf
- Farooq, M.S., Chaudhry, A.H., Shafiq, M. & Berhanu, G. (2011). Factors affecting students' quality of academic performance: a case of secondary school level. *Journal of Quality and Technology Management*, 7 (2), 01-14.
- Hollweg, K. S., Taylor, J., Bybee, R. W., Marcinkowski, T. J., McBeth, W. C., & Zoido, P. (2011). Developing a framework for assessing environmental literacy: executive summary. *Naaee*. Retrieved from <http://www.naaee.net>.
- Kaya, V.H., Godek, Y., Elster, D. & Polat, D. (2019). *Comparison of the main determinants affecting science literacy between Germany, Korea and Turkey*. The Abstract Proceeding of 13th National Science and Mathematics Education Congress (page 255), Denizli, University of Pamukkale.
- Kaya, V. H. & Elster, D. (2018a). German students' environmental literacy in science education based on PISA data. *Science Education International*, 29 (2), 75-87.

- Kaya, V. H. & Elster, D. (2018b). Comparison of the main determinants affecting environmental literacy between Singapore, Estonia and Germany. *International Journal of Environmental and Science Education*, 13 (3), 1-17.
- Kaya, V. H. & Elster, D. (2017a). *German students' environmental literacy as a starting point for science teacher education*. International Teacher Education and Accreditation Congress, İstanbul, Turkey.
- Kaya, V. H. & Elster, D. (2017b). Change in 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.
- Kaya, V.H. & Godek, Y. (2016). Perspectives in regard to factors affecting the professional development of science teachers. *Journal of Human Sciences*, 13(2), 2625-2641.
- National Research Council (NRC). (1996). *National science education standards*. Washington, DC: The National Academies Press. <https://doi.org/10.17226/4962>.
- Nayar, A. (2013). Importance of education for sustainable development, Retrieved 30. 01.2018 from http://wwf.panda.org/about_our_earth/search_wwf_news/?210950/Importance-of-Education-for-Sustainable-Development.
- UNESCO. (2005a). *United nations decade of education for sustainable development (2005-2014): international implementation scheme*, Retrieved 12.12.2017 from <http://unesdoc.unesco.org/images/0014/001486/148654E.pdf>.
- UNESCO. (2005b). UN decade of education for sustainable development 2005 – 2014, Retrieved 12.12.2017 from <http://unesdoc.unesco.org/images/0014/001416/141629e.pdf>.
- Pavlova, M. (2013). Towards using transformative education as a benchmark for clarifying differences and similarities between environmental education and education for sustainable development. *Environmental Education Research*, 19 (5), 656–672.
- Peden, M. I. (2008). Education for sustainable development: knowledge and environment in south african schooling. *Southern African Journal of Environmental Education*, 25, 13-24.
- Peters, M.A., & E. Gonzalez-Gaudiano. (2008). *Introduction. in environmental education: identity, politics and citizenship*, ed. E. González-Gaudiano and M.A. Peters, 1–11. Rotterdam: Sense.
- Scottish Executive. (2006). *Scottish schools (parental involvement) Act 2006*, Scottish Executive, Edinburgh.
- Stabback, P. (2016). *What makes a quality curriculum?*, current and critical issues in curriculum and learning, Retrieved 02.02.2018 from <http://unesdoc.unesco.org/images/0024/002439/243975e.pdf>.
- Tabucanon, M. T. (2010). Education for sustainable development: challenges for transformative education and research. *International Journal of Environmental and Rural Development*, 1 (1), 1-6.
- Tanriverdi, B. (2009). Analyzing primary school curriculum in terms of sustainable environmental education. *Education and Science*, 34 (151), 89-103.