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**Path to a Knowledge Society-**  
**Managing Risks and Innovation**

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# Environmental Literacy, its Components and Significance

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**Abstract**—Studies of environmental science performance in Serbia have revealed unsatisfactory results among students completing the mandatory education. The condition of the environment and protection of its resources call for urgent changes. This article analyses the environmental literacy as a complex construct, consisting of at least three components: cognitive, affective and behavioural. The environmental literacy surpasses knowledge and cognitive skills and includes the affective component: sensitivity, care, self-efficacy, certain attitudes and values, and the actions that correlate with these phenomena. The affective component is a better predictor of behaviour than the cognitive one, which is interpreted in terms of the Theory of Planned Behavior. The author has reservations as regards whether all the components of literacy can be equally facilitated through mandatory education. Finally, recommendations for educational practice are offered.

**Keywords** - environmental literacy, components, relations of components, education

## I. INTRODUCTION

The challenges in environmental protection put before Serbia are persistent and rising. For example, there are more than 800 illegal landfill sites [1]; potable water in the wells and water sources is frequently found contaminated by septic systems is [2,3]; uncontrolled deforestation is dangerously spread [4], and there are many other significant problems and violations.

An achievement study made at the end of primary education in Serbia found that students do have knowledge of the facts in the domain of ecology, but their ability to apply the knowledge and make conclusions is not satisfactory [5]. Previously, the results indicated that Serbian

students are rather unready to behave in an environment-friendly way, and that they do not understand fully how their actions can contribute to the environmental protection [6]. Programme for International Student Assessment (PISA), frequently used as a framework for international comparison of student achievement in science was related to the environmental topics in the 2006 cycle. The results of Serbian student syndicated that more than a half of students were not familiar with the well-known global environmental problems such as global warming or radioactive waste [7]. Actually, PISA performance in the domain of environmental science of Serbian students is under the OECD average, with about 25% of students below level D, and almost 30% of student at this level. The participants who score under level D fail to answer the questions related to basic environmental topics and issues. The rest of the nationally representative 15-year olds (45%) can be considered to have intermediate or higher level of knowledge of the environmental science [8].

The results on the environmental knowledge on the one hand, and the treatment of the nature and its resources on the other, raise the issue of education and its role in elevating ecological consciousness, as well as the issue of the very meaning of environmental literacy – what it means, what it consists of, and how important it is to address it through the education system.

## II. ANTHROPOCENTRISM VS ECOCENTRISM

Anthropocentrism is the understanding of humans-nature relationship where the humans are perceived as the masters of the nature, with the right to use the nature in the way most convenient for us. According to this view, people



are the only living creatures whose life has value, the rulers of destiny of plants, animals and natural resources [9]. The reasoning of ecocentrism is exactly opposite: the nature has intrinsic value and humans are perceived as parts of the nature. Ecocentrists support not only justice among people, but also justice among species, justice between human and non-human worlds, as the human and non-human worlds are mutually intertwined [10]. Continuing to live in accordance with the anthropocentric view, humans fail to understand that mistreating their environment is very costly, leading to not a faraway consequence. Following the course of changes in Science and Social Studies curricula in Serbia, [11] identify dominantly anthropocentric perspective in the 50s and 60s, containing the picture of the nature primarily as a source of resources. If the preservation of nature is mentioned, only instrumental reasons are named for it. Further on, the approach changed through moderate anthropocentrism to clearly dominant ecocentrism. The authors identify a paradox in the 70s curricula: intertwining the topics of environmental problems and the call for its preservation with still persisting anthropocentrically oriented ideas. The period of 80s and 90s is characterised by gradual addition of environmental protection topics, but authors still find them unsatisfactory. Significantly, in the scientific circles the issues of endangered nature had been emphasised since the 70s [11], and UNESCO-UNEP (United Nations Environment Programme) states that the objective of environmental education is gaining awareness of the environmental problems, developing the sense of concern about them, with the proper knowledge, skills, attitudes, motivation and dedication to work on resolving the existing problems [12]. One can conclude that curricula changing policy was strikingly inert, having in mind the significance and the magnitude of the problem and the discrepancy between the standings of the scientific community and the curricula. It is the beginning of the 21st century when ecocentric view becomes predominant in the school curricula, and living creatures' value is construed not through their instrumental role, but through their place in the nature [11].

At this point, it can be understood that a conflict of values and standpoints is possible between different generations. Generations of parents educated according to the values of anthropocentrism, when using animals and

natural resources according to the preferences of humans was perceived acceptable, would bring up the generations of children according to the same system of values. The changed course of values considering the humans-nature relations puts the new generations in conflict of what is taught in the family and considered acceptable, and what is propagated through the educational system. Another obstacle for the embracement of the new, ecocentric view are highly promoted consumer society values. The consumer society is a society based on the mass production and consumption of material goods and services that significantly surpasses the satisfying of the basic human needs. The consumerism is spreading through media and internet, and marketing is widely used to create needs and habits that did not exist previously and convince the individual to buy what one does not actually need [13]. The hyper-production of merchandise as well as its accumulation and disposal cause large damage to the environment. Still, since these consequences are not directly visible and new mobile phones, cars, clothes and shoes represent highly acceptable goal for the society, the education has rather difficult task of modifying the existing system of values, and opposing to the powerful influence of media and marketing.

Beside the anthropocentric and the ecocentric perspective, Environmental psychology and Environmental ethics also recognise biocentric perspective that is opposed to the anthropocentric one, but still distinct from the ecocentric [14,15]. In the biocentric perspective the focus is on living organisms, while ecocentric perspective includes recognising the intrinsic values of abiotic factors and elements (like rocks, soils, rivers and forests) as well. According to some biocentrists, animals are more important than plants, and mammals more than invertebrates, while others hold egalitarian perspective. On the other hand, according to the ecocentrists, the whole ecosystem, including the non-living nature, bears intrinsic value, and merits protection [15].

### III. THREE VISIONS OF SCIENTIFIC LITERACY

If we want to speak about the meaning of environmental literacy we should reach for the definition of the superior construct: the scientific literacy.

Roberts differentiates two approaches (or visions) to defining goals of science education, the first one observes the science from the inside – its theories, methodology, findings; and the

other one observes it from the outside, considering the application of the science and its influence, and the possibilities for the particular product or application to be criticised [16]. The second vision is referred to as the popular scientific culture; it is related to real problems the community is confronted with, and it is contrasted with academic scientific culture, referred to in the vision one [17]. There are cultural differences between the two visions, since the first one refers to “Eurocentric science”, the knowledge produced in Europe and USA by professional scientists, working inside institutions, with the objective to provide benefit for their institutions. Contrary to this, there are “indigenous sciences” which appoint the nature of scientific knowledge that has provided conditions for the survival of the first communities and “neo-indigenous sciences”, which are produced by long-lasting non-Eurocentric cultures [18]. Demonstrating this pluralism in science helps us think of different sources of knowledge that can offer valuable solutions, and it seems that our view science is relatively narrow and exclusive. Being aware of the shortcomings of the existing approaches to science education and the needs of the society, different authors propose the third vision.

The third vision of scientific literacy has been emphasised during the last two decades. The authors speaking of the third vision stress that science education should facilitate critical scientific literacy, political literacy, social responsibility, activism, and advocacy of the social justice and preservation of nature [19-22]. Science is observed as constituent part of the society, and the product of the time and the persisting needs [19]. Reference [23] observe the scientific literacy as a part of good citizenship and place it in the service of the common good and ask for “morally justified and scientifically literate behaviour” [23]. The scientific literacy is observed in the wild, in the practice, and it is described through the lens of an activist and the local community considering the concrete problems to be solved in their surroundings.

In reality, problem solving requires scientific knowledge as only one of the prerequisites. To achieve a change in their surroundings, people may need specific knowledge of the scientific domain as well as political and communicative competencies: it is important to understand the laws and the prescribed possibilities for action, to be able to find sources of important information, but also to be competent to communicate with the

authorities in the specific way, using the demanded administrative language and the channels provided for it. The problems often include competences of experts from different fields. From the example of a symposium held in the Serbian Academy of Science and Arts on small hydropower plants [24], we can see that the problem should be observed from multiple scientific perspectives (for example hydrology, mechanical engineering, sustainable development, ichthyology, herpetology, economy, jurisprudence). Therefore, the action would frequently demand networking of experts competent in different areas, and their connecting with interested and affected members of the local community. This is where the science also finds its purpose and confronts with the demand to be accessible and communicative.

#### IV. WHAT IS ENVIRONMENTAL LITERACY

Charles E. Roth was the first author to introduce the term of environmental literacy in 1968 [25]. Widely used and quoted definition of environmental literacy of [25] reads as follows: “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.” In the quest for the components the environmental literacy consists of, it is necessary to refer to UNESCO Tbilisi Intergovernmental Conference, as rather important event resulting in identifying widely recognised and applied conception of categories of objectives of environmental education: awareness, knowledge, affect, skills, and participation [26]. These objectives laid foundation of many research efforts and instrument constructions. They also indicate clearly that knowledge of the environment represents just one component, and that educating an environmentally literate citizen is a rather complex task. It is not only what we know and understand that matters, but also how we feel about it, and how ready we are to participate and contribute to changing the state of matters.

In the following lines other influential frameworks of environmental literacy will be presented in a chronological order.

a) In 1991 Marcinkowski, identifies nine components of environmental literacy: awareness and sensitivity; respecting the environment: knowledge of ecosystems and their relatedness to social systems; understanding of various problems; knowing strategies for

problem solving; skills necessary for analysis, synthesis and evaluation of the information; personal investment and sense of responsibility; active involvement [27].

b) Hungerford et al., 1994 discriminate four components of environmental literacy: cognitive – knowledge of ecological and socio-political foundations, ability to evaluate problems and apply strategies, and to create plans of action; affective dimension – includes attitudes of empathy and care as well as the willingness to act. They also distinguish locus of control and feeling of responsibility and, as fourth dimension – involvement in environmentally responsible behaviour [27].

c) North American Association for Environmental Education [28] also recognises four components: the ability to analyse and make interpretations, being familiar with methods of inquiry and capable to formulate explanations; knowledge of environmental processes and systems; having skills necessary for analysing and coping with the problems, citizenship skills; personal and civic responsibility – willingness and ability to act according to one's own informed judgement.

d) One of the large national projects relying on UNESCO objectives of environmental education is The National Environmental Literacy Assessment (NELA) Project, realised in the USA [29]. The project focuses on middle school students because it is estimated to be the developmental age that offers the last viable opportunity to introduce significant change and avoid further destruction of the environment [29]. NELA project has developed further the framework for assessing the environmental literacy that proposes answers to the questions: which knowledge, competencies, disposition and types of behaviour constitute environmental literacy and what their mutual interconnectedness is. This framework can be understood as a very thorough list of possible research goals when dealing environmental

literacy, or as the ideal picture of environmentally literate citizen. This is why we have selected to present wholly the components of the Environmental Literacy identified in it (see Fig. 1). Clearly, all the components cannot be assessed in a single study; especially if it tends to determine the interactions between the components as well [30].

e) The international assessment PISA 2006 measured environmental literacy through the following components: environmental science performance (scientific knowledge and use of that knowledge, understanding the features of environmental science as result of knowledge and learning, awareness of the ways environmental science can influence our lives, willingness to engage in this science as reflective citizen); students' attitudes and learning about the environment; familiarity with, responsibility for, and optimism toward general environmental issues; awareness and self-perception of one's ability to understand complex environmental issues [8].

A recent overview of environmental literacy components lists the following: knowledge about environment, pro-environmental attitudes, and sensitivity for the problems environment is confronted with, self-efficacy, capability to analyse the problems, and the actual behaviour [30-33].

Comparing to the views of scientific literacy, environmental literacy definitions seem to be more consistent. They tend to observe the science from the outside, from the point of view of its repercussions. They also tend to give an active role to the citizens, placing participation and active citizenship among the constituents of the environmental literacy [12,28]. Therefore, the environmental literacy definitions correspond largely to the third vision of environmental literacy that places social, political and cultural questions in focus, emphasising the active engagement of an individual [16].

TABLE I. MEASURING ENVIRONMENTAL LITERACY IN FIVE COUNTRIES.

Country	USA, 2018	Taiwan, 2018	Greece, 2017	Israel, 2008	Turkey, 2009
Sample	Students of agriculture	1 <sup>st</sup> to 4 <sup>th</sup> year undergraduate students	1 <sup>st</sup> & 3 <sup>rd</sup> grade of high school	6 <sup>th</sup> & 12 <sup>th</sup> grade students	Pre-service teachers
Environmental literacy components	Knowledge, skills, affect/hope, behavior [26].	Cognitive, affective, behavioral component	Knowledge, affect, cognitive skills, behavior [28].	Knowledge, attitudes, behavior	Knowledge, attitudes, perception of environmental uses, concern
Cognitive component	Knowledge of ecology referring to physical and ecological systems [30]; The ability to comprehend and analyze environmental issues	Ecological and socio-political foundations: knowledge of natural systems, of environmental issues, and of appropriate action strategies	Knowledge of ecological foundations; skills of issue identification and analysis and action planning	Knowledge of global issues, national issues, general ecological principles	Knowledge of global issues, national issues, general information on ecology
Affective component	Hope- Affect including self-efficacy (belief that one can achieve the desired outcome [34] and response efficacy (belief that one's actions would bring the desired outcome [35])	Environmental awareness and sensitivity, environmental values, decision-making attitudes	Verbal commitment (intention to act environmentally friendly); Environmental sensitivity and general environmental feelings	Awareness, willingness to act, sensitivity to environmental issues and affection for nature, sense of responsibility	Attitudes – general, refer to ecocentric vs anthropocentric perspective; perceptions of environmental use – attitudes considering particular behaviors concerning environment; feeling concerned about global environmental problems
Behavioral component	Pro-environmental behavior, like recycling or conserving water	Intention to act, involvement in environmentally responsible behavior; environmental action strategies and skills	Actual commitment (pro-environmental behavior)	Consumption patterns, individual conservation, environmental activism, leisure involving nature	
Mutual relations of components	Knowledge and hope predict behavior and cognitive skills. Skills do not predict behavior. Interaction between knowledge and hope is the best predictor of behavior.	Cognitive component is related neither to affect nor to behavior. Affective and behavioral component establish strong correlation.	Verbal commitment has medium correlation with actual commitment; environmental sensitivity (affective component) correlates weakly with actual commitment; verbal commitment has very weak correlation with environmental sensitivity. No data on cognitive-behavioral component relationship	Environmental knowledge and behavior are not related; Attitudes and behavior have medium correlation.	Knowledge is weakly related to environmental concern and perceptions of the environmental use, but is not related to general environmental attitudes. General environmental attitudes and attitudes concerning the environmental use are related to environmental concern.

## V. MEASURING ENVIRONMENTAL LITERACY

In the following lines we shall present shortly the operationalisations of environmental literacy used in five studies measuring this construct that were conducted in five different countries: USA [33], Taiwan [36], Greece [37], Israel [38], and Turkey [39]. The operationalisation of the environmental literacy is presented in the Table I.

If we review the Table I, we can observe that different studies assessing environmental literacy include different number of components and different subcomponents. Still, knowledge as (subcomponent of) cognitive component is consistently present, indicating that from the point of view of the scholars it is unavoidable part of environmental literacy measurement. Further on, knowledge is measured differently. For example, [36] include beside knowledge of ecological science, knowledge of the action strategies, and [37] test only the knowledge of ecological foundations. The affective component sometimes includes values [36], self-efficacy, response efficacy [33], and frequently includes emotions, like sensitivity or concern [36-39]. Taking a look at the components under the umbrella of environmental literacy, we can agree with the observation in [33], stating that the affective component seems most variable.

Also, we can see in the Turkish assessment [39], that an environmental assessment study can omit one of the three main components, in this case the behavioural one that was not included in the model, while the affective component was represented by three subcomponents. Different choice of components, and different manner of their operationalisation make comparisons of the results unreliable. Probably the most controversial relationship seems to be the relationship between environmental knowledge and behaviour. Naturally, the results vary not only among the present studies. While the relation of affective and behavioural component is usually found significant [33,36-38,40] the studies of knowledge and behavior relations offer inconclusive results. In some studies knowledge-behaviour relation is statistically significant [33,41,42], but not in the others [36,38,40]. According to Fig. 1 [30], the environmentally responsible behaviour is not affected directly by knowledge of science, or being informed of the

existing problems, or having the knowledge of the ways to act. Knowledge demands competencies: to analyse issues, bring one's own judgement, create concrete plans, in order to result in concrete behaviour. Also, our knowledge is in interaction with our dispositions – like motivation, self-efficacy or sensitivity. Based on the results presented in [33], it is interaction of cognitive and affective component that needs to be taken into consideration, in order to determine the actual role of knowledge. This interaction is observed in the study of Meinhold and Malkus suggesting that the individuals who have more ecological knowledge develop stronger correlation of pro-environmental attitudes and behaviour [43]. It can be interpreted as the necessity of knowledge for achieving consistency between attitudes and behaviour.

## VI. DISCUSSION AND CONCLUSION

Obviously, environmental literacy surpasses knowledge and cognitive skills and includes the affective component: sensitivity, care, self-efficacy, certain attitudes and values. It also includes actions based on the previously mentioned. Therefore, it is not appropriate to measure environmental literacy without taking into account the attitude, values, emotional involvement and readiness to act, or to consider literate an individual who expresses the knowledge in the academic context only. Environmental literacy means action. This action can include engagement in different manners: particular consumer's behaviour – for example buying less objects, taking the merchandise in recyclable packaging or without packaging; specific actions in the household – like composting or separating garbage; field actions – collecting garbage from green areas and rivers; planting trees; social activism – participating in environmental movements, advocacy for changes of the regulations in order to protect the environment, protesting...

The importance of changing attitudes, values and habits and the position of science in dealing with it is briefly described in the famous quote of Mr James Gustav Speth, the former Dean of the Yale School of Forestry and Environmental Studies, founder and president of the World Resources Institute: "I used to think the top environmental problems were biodiversity loss, ecosystem collapse and climate change.

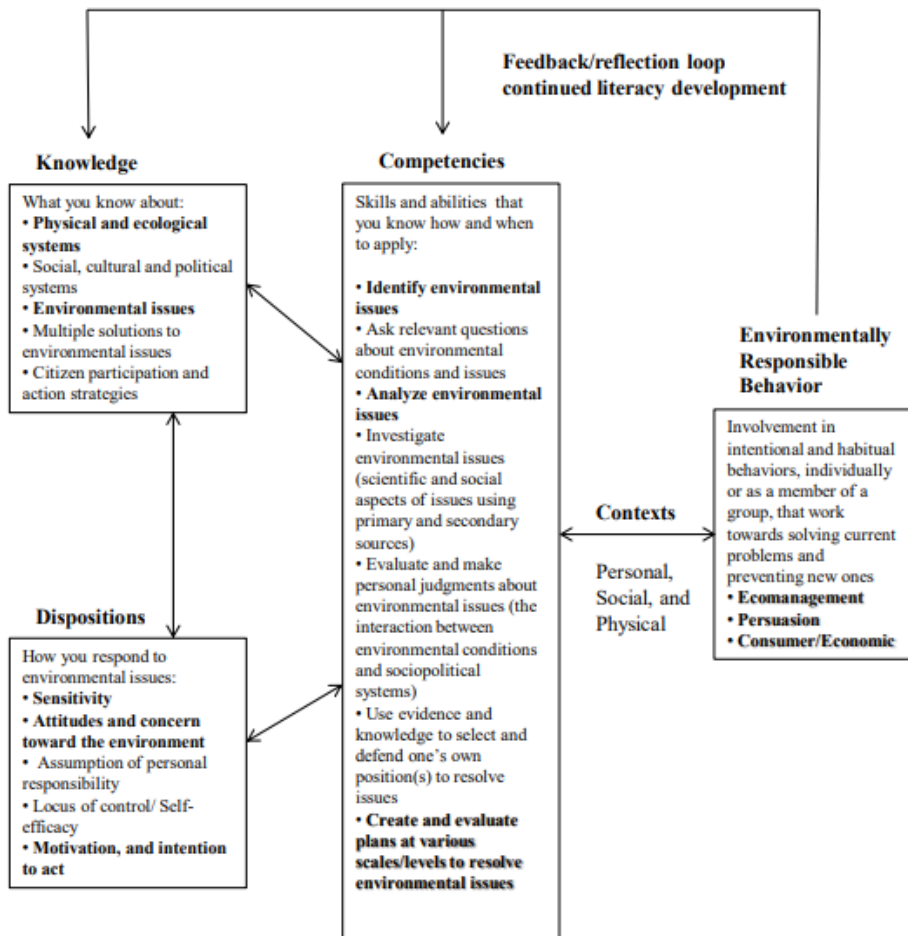


Figure 1. Components of the domain of Environmental literacy [29,30]

I thought that with 30 years of good science we could address these problems, but I was wrong. The top environmental problems are selfishness, greed and apathy, and to deal with those we need a spiritual and cultural transformation. And we scientists don't know how to do that" [44].

Observed differences in knowledge-behaviour and affect-behaviour relationships, where the affective component, unlike the cognitive one, appears in numerous studies as correlate of behaviour [33,36-39], can nicely be interpreted by [45], Theory of planned behaviour. The actual antecedent of the behaviour is the intention to perform a certain action together with perceived behavioural

control (construct similar to perceived self-efficacy). These intentions are determined by attitudes towards the behaviour, subjective norms and actual behavioural control; that in turn depend on the beliefs (about possible consequences, about social surrounding expectations and about one's own ability to achieve the goal). And beliefs are based on knowledge, but vary depending on cultural, personal and situational factors as well [45]. Therefore, the intention to behave in a certain manner and perceived ability to perform should be considered the best predictor of that actual behaviour, influenced, among other factors, by attitudes towards the behaviour, that are under the influence of knowledge, among other factors. The proposed chain of influence makes

knowledge a rather distant and plausibly weak predictor of the actual behaviour and demands investigating the interaction of knowledge and attitudes, and taking the context and the social norms in the account. This theory also explains how demanding and winding the path to the necessary behavioural changes can be.

Considering the unsatisfactory results of environmental knowledge assessments in Serbia [5,8] and the alarming state of fact with regard to the preservation of nature and its precious resources, we touched upon in the introduction, it becomes clear that not only more efficient ecological education is necessary, but the change of behaviour is urgently needed as well. It is not realistic to expect the mandatory education in Serbia to develop equally knowledge, skills, civic activism, sensitivity, pro-environmental attitudes and values, the intention to act and readiness to change the existing habits. Having in mind all the variety of constructs placed under the affective component, it seems almost impossible to address the affective dimension with all its meanings not only in one research effort, but even more in the educational context, with restricted time and already specified goals primarily focused on its cognitive component. Still, it is very important to facilitate it, since the knowledge and skills themselves are not sufficient to create an intention or achieve the actual behavioural change. Through schooling, not only knowing and understanding of the environmental science contents and principles and the main issues should be rewarded. It also stands for the proper attitudes and the actions children can display (like separating trash for recycling, making bird houses, advocating in favour of ecocentral values and behaviour, helping the injured animals, planting trees, reusing water bottles, putting food in reusable packages instead of buying new package each time...), that should be taught through the example of the teachers' behaviour and the organised outdoor activities. School should also address the widely spread antropocentric and consumer society values and ways of living that make large obstacle towards accepting pro-environmental behaviour and introducing change. This effort of the education should largely be supported by the legislation and the media, with the goal to make pro-environmental attitudes, feelings and behaviour a mainstream.

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