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From Environmental Action to Climate Change Knowledge and Back

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Abstract Considering the importance of climate change issues as the integral part of present day's students' body of environmental knowledge, as well as a needful part of their social and personal life, this paper will be focused on the scientific research of the organized academic environmental activities (promotion action on climate change) in achieving learning objectives of climate change knowledge. Our research relied on growing body of research and case studies that have predefined environmental education and its objectives in education for sustainable development, with deep understanding of environmental issues and skills for active participation in sustainability problem solving. For the purpose of our research, we surveyed students of the University of Belgrade - Faculty of Organizational Science, Serbia, not only on their attitude toward the environmental action referred to gaining climate change knowledge, but also on their achievement levels in faculty environmental studies program. An analysis of the results was carried out using the SPSS 24 software package.

KEYWORDS: environmental action • climate change • climate change knowledge • project-based learning

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1 Introduction

Environmental problems (Bonnett, 2007; Mert, 2006; Robert, Flood & Carson, 1993) reached their critical point in the 21st century and continue to rapidly grow: global warming, the deterioration of living conditions, disruption of the ozone layer, the impacts of conservation, increase in the amount of solid waste, radioactive contamination, destruction of forests, the extinction of plant and animal species... (Petrović, 2016). Further on, the increase of the global population has produced growth of natural resources consumption (Symth, 2004).

The environmental crisis is getting worse and leading to the necessity of adopting of the concept of sustainable development in which environmental education and education for sustainable development play a key role as the most important part for a sustainable future (UNESCO, 2012). In the late eighties of the last century, the concept of Education for Sustainable Development is developed, whose goals were defined in the nineties in Agenda 21 (1992). It must be noted that knowledge itself is not enough for a responsible attitude towards the environment (Hines, Hungerford, & Tomera, 1986/87; Hungerford & Volk, 1990), and that adequate education for environment must have the following outcomes: a deep understanding of the environment, skills and opportunities to actively participate in solving environmental problems.

Furthermore, global warming and consequently climate change are the biggest environmental problems which representing the most serious challenge for the present and future generations of humans because they are bringing a new understanding of progress and development of science and technology. The United Nations recognized "the link between climate change and human rights as an important step towards protecting the fundamental rights of communities across the planet" (UNEP, 2015). These are the reasons why it is considered that education must be "an essential element of the global response to climate change" (UNESCO, 2017). Such education should be "encouraging innovative teaching approaches to integrate climate change education (...) as well as enhancing non-formal education programmes" (UNESCO, 2017).

Bearing the above in mind, in our paper we chose to research students' views and opinions related to their participation in the project of promoting practical knowledge on climate change at the Belgrade Science Festival and consequently improvement of their knowledge. Our research included all 45 students (100 percent) enrolled at the elective course Design for Environment at the University of Belgrade - Faculty of Organizational Sciences, the Republic of Serbia, who participated in the project "Beware: save the polar bear." An analysis of the results was carried out using the SPSS 24 software package.

2 Background

2.1 Environmental education and climate change knowledge

The Belgrade charter talks about a new approach to social development that emphasizes the protection and improvement of the environment, which is only possible with the reform of the education system, because "environmental education is the most important element of common response to the environmental crisis" (UNESCO-UNEP,1975).

Tbilisi declaration adopted in 1977, provides a detailed description of the objectives of environmental education. It talks about the need to foster awareness and concern about the economic, social, political and environmental interdependence in urban and rural areas, providing a chance for everyone to acquire knowledge, skills and abilities necessary to work on the preservation and improvement of the environment. "Environmental education is a process that allows individuals to explore environmental issues, engage in problem solving, and take action to improve the environment. As a result, individuals develop a deeper understanding of environmental issues and have the skills to make informed and responsible decisions" (EPA, 2016).

The universal goals of environmental education included (UNESCO-UNEP, 1977):

1. *Awareness* - help community groups and individuals in gaining awareness and sensitivity towards the environment and the problems associated with it.
2. *Knowledge* - help community groups and individuals to acquire varied experience and a basic understanding of the environment and problems related to it.
3. *Attitudes* - help community groups and individuals in the adoption of a set of values and a sense of interest in the environment and problems related to it.
4. *Skills* - help social groups and individuals acquire the skills for identifying and solving environmental problems.
5. *Participation* - to provide opportunities for community groups and individuals to actively participate in solving environmental problems at all levels of work.

When it comes to typical environmental education relating to climate change, it must be emphasized that knowledge about climate change "helps young people understand and address the impact of global warming, encourages changes in their attitudes and behavior and helps them adapt to climate change-related trends" (UNESCO, 2017).

2.2 Environmental education and climate change knowledge

Created in 2007, the Science Festival was organized in order to call public attention to science as an inseparable part of life and to provide an inspiring, new and fresh look at different scientific fields. From the very beginning, the essential part of its mission was to bring science closer to non-scientific audience and to provoke interest in scientific work, and furthermore in understanding its impacts in everyday life.

Ten years since its launch, the Science Festival is far beyond its humble beginnings: at this moment, it is one of the top five science festivals in Europe, while at local level SSF represents the most popular and most important annual scientific event. The last five Science Festivals recorded 30,000 visitors in four days and hosted 45 scientific and educational institutions with over 550 scientific demonstrators.

Since 2007 the Science Festival is a member of European Science Events Association (EUSEA) and in 2015, the EUSEA Annual Conference took place in Belgrade, Serbia, hosted by the Serbian Science Festival.

"The Festival is guided by the idea to popularize science in order to reach a broad audience, and to provide its own contribution to the promotion of science and technology pointing to their crucial importance in a modern society. Countless scientific exhibitions, lectures, interactive presentations, well-known contributing lecturers, enthusiastic audience and more than 200,000 visitors from 2007 to the present, are the best proofs that it succeeded." (Science Festival, 2017)

The climate change project "Beware: save the polar bear" presented at the Science Festival had a goal to educate visitors of Festival about climate change and climate change consequences, the not-so-slow extinction of polar bears, and polar caps melting. Polar bears are very important for addressing climate change because they depend on sea ice for survival and are directly affected by climate change – moreover, they serve as an essential indicator of species, due to the fact that ice is actually melting, and that the atmosphere is warming. The preservation of the polar bear, means that we need to restore the lower levels of carbon dioxide in the atmosphere, prevent the melting of the Arctic ice, create reforestation of Amazon, and reduce greenhouse gas emissions.

Visitors of the Festival, stood on a moving platform and entered an original created virtual reality simulation that featured a live feed of them standing on a tiny iceberg that was melting, thus showing them how it actually felt for the polar bears, losing their habitat right under their feet. Beside the exhibition of project itself and the simulation game, students educated visitors on the greenhouse effect, facts on climate change and global warming and polar bears, and gave them tips on how to reduce their carbon footprint.

3 Methodology

For our research we chose the ungraduated students of the University of Belgrade – Faculty of Organizational Sciences, enrolled at the elective course Design for Environment in the winter semester of 2016/2017 academic school year, which participated in the project "Beware: save the polar bear" in the organization of the Centre for environmental management and sustainable development and EkoFON (students' environmental organization) of the Faculty of Organizational Sciences – University of Belgrade, the Republic of Serbia.

At this course, a framework and a curriculum for good environmental higher education are developed on a wide scale of scientific and practical knowledge of the environment and environmental science as a good benchmark for the adequate improvement of students' knowledge, as well as a promotion of higher order thinking skills in a cooperative context for learning and evaluation (NAAEE, 1996; Petrovic, Jeremic, Petrovic, & Cirovic, 2014). It must be noted that this course is also based on project-based learning, as relevant learning model for the 21st century (Baker, Trygg, Otto, Tudor, & Ferguson, 2011). This teaching method enables students to gain knowledge and skills by working on an original project that addresses a global issue – climate change. In this way, in addition to environmental knowledge, students get familiar with: how to promote environmental protection, environmental science in its broadest sense, as well as management, project management, logistics, human resource management, event management, financial management, marketing, public relations.

After the Science Festival in Belgrade that took place in December of 2016, the authors of the paper conducted the research. For the purpose of our study, we uses special designed questionnaire. The questionnaire consisted of 21 questions in total. The first four questions were general. From question 5 to question 11, participants were asked to give their response on their views and impressions on Belgrade Science Festival. From question 12 to question 21, the participants were asked to express their opinions about: preparations for climate change project, participation in the project at the Science Festival, motivation for acquiring more specific environmental knowledge, possible changing of environmental behavior as well as further engaging in inenvironmental actions. The Likert scale from 1 to 5 has been used (1 – Absolutely no, 2 – I don't agree, 3 – I don't know, 4 – I agree, 5 – Absolutely yes). These questions fall into the category of the most significant ones because they directly refer to the main goals of our research and research questions:

An analysis of the results was carried out using the SPSS 24 software package. Descriptive statistics have been used in order to analyze the characteristics of the sample. The Mann Whitney U Test was conducted in order to compare two independent groups in regard to a observed scale variable. The *p* value is used to indicate if the differences between two particular groups that were in this research are statistically significant (where $p<0.05$ is considered statistically significant at the 95% confidence level).

4 Results and discussion

When it comes to the students who took the survey:

- 24 of them (53.3 percent) were female while 21 of them (46.7 percent) were male.
- Of the surveyed respondents 25 of them (55.56 percent) completed a 4 year high school, and 20 of them (44.44 percent) a secondary occupational school.
- 16 respondents (35.6 percent) is from Belgrade, while the other 29 of them (64.4 percent) are from different cities of the Republic of Serbia.

After descriptive statistics, Mann-Whitney rank test has been used in order to examine differences in answers between two categories:

- Female/male ratio,
- 4 year high school completed/ocupational school completed ratio.

When it comes to testing the difference in the responses of female and male students, there are observed differences in responses to the allegations:

- "This type of work motivated me in environmental change for the better".
- "This type of work has motivated me to continue to participate in environmental actions".

The results by gender show that:

- Female students showed a greater degree of willingness for environmental change for the better (mean rank for women - 26.44 and for men - 19.07, significant $p = 0.037$).
- Females showed a greater willingness to participate in future environmental actions (mean rank for women - 26.42 for men - 19.10, $p = 0.040$ significant).

The average score for the statement: "This type of work motivated me in environmental change for the better" for female students is 4.54 and for male students is 4.14, which shows greater difference between female and male students. Also, there is a greater difference in the statement: "This type of work has motivated me to continue to participate in environmental actions" where the average score for female students is 4.58, while for male students is 4.09. The arithmetic mean by gender for these two statements and absolute arithmetic mean difference are given in the Table 1 and Figure 1.

Table 1. The arithmetic mean of statements by gender and absolute arithmetic mean difference

Statement	**Arithmetic mean (t_n)**		**Absolute arithmetic mean difference**
	Female	**Male**	
This type of work motivated me in environmental change for the better	4.54	4.14	0.40
This type of work has motivated me to continue to participate in environmental actions	4.58	4.09	0.49

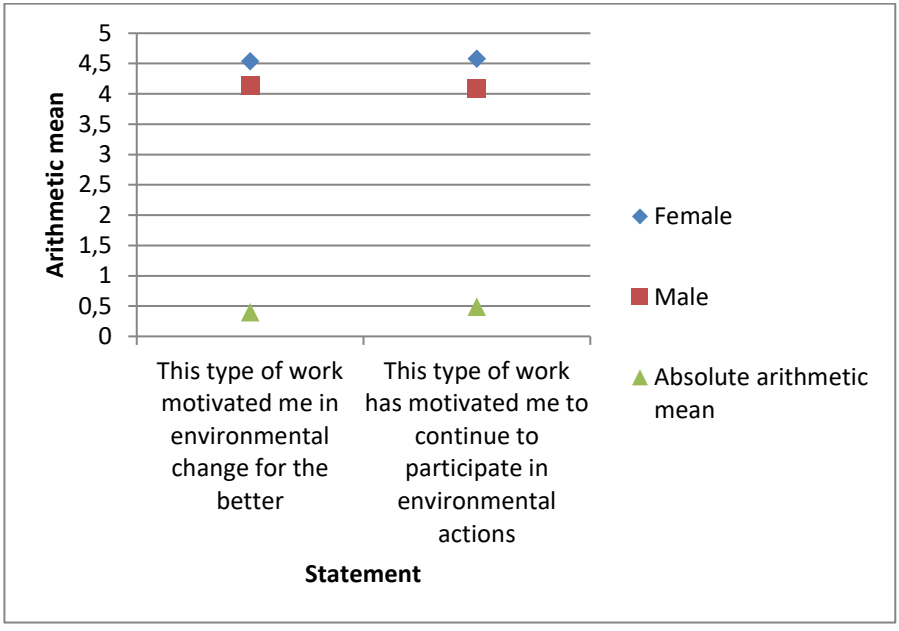

Figure 1. The arithmetic mean of statements by gender and absolute arithmetic mean difference

These results could be explained by previous research that show that (Eisler, Eisler, & Yoshida, 2003):

- Females have more positive attitudes toward nature and the environment than males.
- "Females are more likely than males to show a motivation to behave responsibly to protect nature and the environment".
- Females showed more hope than males of making the world a better place by changing their environmental behaviors.

Obtained results are of great interest having in mind the importance of the linkages between environmental protection and security and gender roles as well as necessary involvement of female in environmental education (OSCE, 2009). Also, engaging female in environmental protection helps societies to develop "the sense of responsibility needed to maintain a good balance between humans and the earth's resources" (UN, 2002).

In addition, in our research we examined the differences in the responses of students who have completed 4 year high school and university students who have completed secondary occupational school. A statistically significant difference was found in the assessment of only one claim: "This type of work has motivated me to continue to participate in environmental actions." Results show that students who have completed a

4 year high school are more willing to participate in environmental actions than the students who have completed an occupational school (average ranking for 4 year high school students - 26.4, the average ranking for occupational school students 18.75, significance $p = 0.033$).

These results can be explained on the basis of the curriculum in biology and sociology as subjects in 4 year high schools where they taught the basics of ecology and environmental problems (Univerzitet u Nišu, Prirodno matematički fakultet, 2017) as opposed to occupational schools that do not have these subjects. On the one hand, this is associated with the results of previous studies that have shown that when it comes to environmental education in the Republic of Serbia, the data about educational curriculum and programs has shown an evident lack of formal and permanent environmental education at all levels of formal education (Klemenovic, 2004; Pavlovic, 2011; Petrovic, 2010; Petrovic, Jeremic, Petrovic, & Cirovic, 2014; Trumic, Petrovic, & Radojicic, 2009). On the other hand the results of our research show the necessity of not only to implement formal environmental education, but of the development of such education, which includes the necessary environmental activities with the aim of promoting and protecting the environment in the long run. Or environmental education must include "participation in activities that lead to the resolution of environmental challenges" (EPA, 2016).

What should be pointed out as the biggest success of the project "Beware: save the polar bear" is the fact that 40 of the surveyed students (88.9 percent) answered affirmatively to the question whether they would take part in the Science Festival again, and that the opinions of students on project-based learning organized in this way are:

- A good way to gain knowledge in the field of ecology and environmental protection.
- An interesting and pleasant experience.
- Gained new knowledge and experiences.
- Fun, interesting and educational.
- The Science Festival and this project encouraged me to think more about subject of climate change and change my behavior for the better.

Further on, in order to evaluate the student's satisfaction with their preparation and participation in the project "Beware: save the polar bear" as well as their assessment to the statements relating to their motivation to learn more about environmental issues treated by the project - climate change, and then consequently change their environmental behavior and continue with environmental activities, the students gave marks on a rating scale from 1 to 5 based on the truthfulness of the statement (1 – Absolutely no, 2 – I don't agree, 3 – I don't know, 4 – I agree, 5 – Absolutely yes), and we calculated the arithmetic mean. The ranked results based on the assessment given by students to our 10 statements are shown in the Table 2.

Table 2. The ranked assessment of statements by students

Statement	**Arithmetic mean (t_n)**	**Rank**
I would participate again in this or similar activities	4.87	1
Preparations for the Festival have helped me to better assimilate knowledge on climate change and polar bears	4.67	2
This type of work has motivated me to learn more about ecology and environmental protection	4.64	3
Participation in the Festival was interesting and fun	4.62	4
Participation in the festival has helped me to better assimilate knowledge on climate change and polar bears	4.60	5
This type of work has motivated me to learn more about climate change and polar bears	4.51	6
Other subjects should incorporate participating in similar projects	4.42	7
This type of work has motivated me to change my environmental behavior for the better	4.36	8
This type of work has motivated me to continue to participate in environmental actions	4.36	8
Preparations for the Festival were interesting and fun	4.16	10

From the calculated results the following can be concluded:

- The highest average rating of 4.87 received the statement: "I would participate again in this or similar activities" (rank 1), which says that the students liked this active method.
- Next, the average score of 4.67 for the statement: "Preparations for the Science Festival have helped me to better assimilate knowledge on climate change" (rank 2) which shows that project-based learning gives better results in gaining knowledge and teaching the curriculum.
- Statement: "This type of work has motivated me to learn more in ecology and environmental protection" also received a high rating - 4.64.

4 Conclusion

The gained results from our research showed following:

- Students who have completed 4 year high school are more likely to participate in the environmental actions.
- Project-based learning as a this teaching method resulted with students' showed greater motivation to learn something more, better acceptance of knowledge and willingness to participate again in similar activities.
- Female students showed a greater degree of willingness for environmental improvement and participation in environmental actions.
- Gender roles are significant predictors of perception of nature, environmental problems and environmental behavior.

Definitely, the survey results showed a positive result on our research questions, and encouraged us to continue with this kind of specific project-based learning in higher environmental education. This specific research shows us that this teaching method is without a doubt, a tool of students' interest.

Beside this, a growing number of educators are facing the challenges of modern higher education, such as keeping students motivated and increasing the knowledge and awareness on specific problems. Our climate change orientated case study was an excellent way to make students interested in the core of this important global environmental issues. Our results also pointed out the effectiveness of the proposed project application in improving the students' scientific environmental knowledge.

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