

Engaging Students in Science Using Project Olympiads: A case study in Bosnia and Herzegovina

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Abstract: Making science enjoyable inspires students to learn more. Out-of-class activities such as science fairs and Olympiads, serve as reasonable informal learning environments that demand attention. The association of students' involvement in these activities with increased student interest in science followed by the selection of science-related careers, should motivate all in-charge stakeholders. In this work, we analysed the outcomes of the Bosnia Science Olympiad (BSO) as the first national Science Olympiad in Bosnia and Herzegovina (BiH), aiming the improvement of science education and bringing different ethnic groups under the umbrella of science, in a post-conflict area. The two-day endeavour held in Sarajevo includes competition in four science-related categories (Environment, Engineering, Have an Idea, Web Design) and social activities. In this work, the comprehensive data, including participants' gender, their ethnic background, cities, schools, and supervisors, over five years, was analysed. The number of participating high-school students increased from 78 to 143, of supervisors from 21 to 95, and of schools from 7 to 15, reaching a wide demographic acceptance to cover all ethnic regions in BiH. The relationship between gender and the selection of a category, shows bias of male participants towards Web Design (21%) and Engineering (40%), and of female students towards "Have an Idea" (40%) and Environment (44%) categories. The contribution of BSO choosing a science career, getting socialized without prejudices, and the improvement of students' self-confidence, were as well addressed. Our work demonstrates a model work to successfully promote science in post-conflict settings.

Keywords: *Olympiad; Science; STEM; education; ethnic diversity; Bosnia and Herzegovina*

Introduction

Obstacles of Science Education and the Role of Project Olympiads

To achieve the required level of science literacy and teach science to modern-day students, societies need a well-established educational system and curriculums integrated with technology, engineering, and mathematics (STEM) (Next Generation Science Standards: For States, By States, 2013). However, there is insufficient theoretical and practical literature on the ways to integrate STEM and improve the

learning outcomes of individual students (Thibaut et al., 2018). Reports show that there are serious concerns even in developed countries for the completion of satisfactory STEM standards. An indicative report of Programme for International Student Assessment (PISA) in 2015, shows that European developed countries like Italy, Sweden, Spain, and Luxembourg had a mathematics and science score on or lower than the mean of all countries in the Organization for Economic Co-operation and Development (OECD, 2016). Practical means of reflecting the students' science literacy is even more important in international schools all over

the world, where students with English as Second Language (ESL) perform worse in Science classes due to the language barriers. This is well documented in standardised testing for science literacy (The Nation's Report Card, 2016). The additional obstacle is introduced in conflict and post-conflict areas where the burden upon the education systems move teaching science from the centre-stage, that it deserves, and makes it not a core component of the society (Hayes & McAllister, 2009).

The first step to achieve a successful STEM integration lies in aligning the teachers' pedagogical methodologies with the standards of teaching science, and by energizing the educational systems by higher levels of organization (Top et al., 2015). In this context, out-of-class activities serve as reasonable informal learning environments that demand attention. These activities include, but are not limited to, science fairs and science Olympiads. Numerous studies show the association of students' involvement in science fairs with increased student interest in science, and the increased selection of science-related careers (Grinnell et al., 2018; National Research Council, 2013). The research projects that students develop during a science Olympiad, on the other hand, enhance the understanding of theoretical content by bridging the scientific inquiry to the real world, and this results in the increment of science literacy (Ekmekci et al., 2018). Furthermore, studies show that the essential 21st-century skills get cultivated in students participating in science fairs and Olympiads, such as critical thinking, communication, collaboration, and creativity (Sahin, 2013). Making science enjoyable inspires students to learn more. Science Olympiad is a practical method to allow students to be hands-on in science and to apply their ideas through experimental

research projects. Participation in an Olympiad helps students develop perspectives and skills in multiple fields such as science education, social interaction, group-level representation, shared representations, and ease of conversation among adult educators through back-and-forth dialogues (Echterhoff, 2009; Garrod & Almeida-Porada, 1994; Romney et al., 1996). When set alongside the regular student obligations that frequently make students tedious (such as homework, exams, and tests) (Fulgini & Hardway, 2006); the extracurricular activities maintain the mental, physical, and psychological vitality of students (Pope et al., 2015). By this natural boost of student engagement, these activities result in the enhancement of attention given to the understanding of core scientific concepts (Weir, 2016); particularly, high-school students' enthusiasm and productivity show to be critical factors for their involvement in science (Lent et al., 2008; Miller et al., 2002). Another benefit of science Olympiads is that they guide the participating students in choosing a career for their future studies (Basu & Barton, 2007; Drew, 2011; Hannover & Kessels, 2004). If the students can discover their strengths and talents, it opens the doors for them to potentially succeed more in the future. Choosing the career pathway is one of the hardest decisions a high-school student has to make. Their views are affected by cultural stereotypes, parental, familial, or peer influences, and thus, the learning experiences during high-school play a major role in their critical decision (A. Wigfield & Eccles, 2000). Besides the expectancies and the values of the students, previously proven success in specific courses is another driving force behind their future career choice (Simpkins & Davis-Kean, 2005; Watt & Durik, 2006). Therefore, science fair and Olympiad projects are places for the students to put forward a question,

design their research methods, analyze their observations, do laboratory or home experiments, see peer-projects, and compare them to their projects. This gives them the experience of a full scientific inquiry (Kruse et al., 2013).

As a result, the establishment of large-scale activities needs to be considered carefully to ensure better engagement of students in science. These activities provide a platform for the inclusion of particularly important under-represented groups such as females and minorities. In this way, the organization of Science Olympiads increases and diversifies the talent pool (Estrada et al., 2016; National Research Council, 2013).

Attitude towards science, achievement motivation and science Olympiads

Attitude towards science (ATS) explains the feelings that students have towards science and it describes their beliefs and preferences about science. This can be positive or negative (Kususanto et al., 2012). Klopfer identified the behaviors that affect science attitude as the acceptance of scientific inquiry as a way of thought, enjoying learning science, the establishment of interests in science, and pursuing a career in science (Klopfer, 1973). Kind et al., on the other hand, related the attitude towards science with seven concepts: Learning science in school (1), Practical work in science (2), Science outside of school (3), Importance of science (4), Self-concept in science (5), Future participation in science (6) and Combined interest in science (7) (Kind et al., 2007; Kususanto et al., 2012).

One of the most prominent theories on career choices, the Expectancy-value theory of achievement

motivation, explains that the tendency of students to select mathematics and science as their career is determined by their personal assessments of the probability of success in the area, so it is an achievement-related choice (Allan Wigfield & Eccles, 2000).

Based on these studies, many experiences that students have while participating in a science competition or Olympiad serve as an excellent opportunity for building attitudes towards science and affect positively the selection of a science-related career.

Collaboration and the Power of Synergy

Working on a project motivates the group members to communicate with each other and share their ideas. This is a way to collaborate with others on the same task. With group norms and conventions being set, this leads to predictable and stable patterns of behavior for the participants of the working group (Garrod & Doherty, 1994). Emotional power always increases the quality of work, especially if group members' synergy focuses on the same project. The young students learn the power of synergy and collaboration while they are focused on the same point. This improves the individual cognition at the expense of social and environmental influences on teaching practice (Windschitl et al., 2012). The collaboration of students during the project preparation and presentation stages, reinforces the twenty-first-century skills, such as collaboration (Walan & Ewen, 2018).

Gifted Students and Talent Development

Another benefit of science Olympiads is that a platform for talented students is built. It is no surprise that each school and class has talented students interested in their careers, ready to do more for it

(Andersen & Chen, 2016). Although general interest and competence are the main aims of science education, science curriculums should include extra-curricular activities for already talented and science-orientated students. This can foster their developmental process. Therefore, to successfully direct the top-tier students' developmental process, a reasonable level of ability and strong motivation is required (Renzulli, 1978), readily achievable by science Olympiads.

Science teachers

As Walan et al. points out, teachers have a high impact on sparking interest for STEM (Walan & Gericke, 2019). They have a great impact on STEM education, as it is very important to relate the science topic they teach to everyday life, have a deep knowledge of the topic, and effectively communicate the topic. The continuous pedagogical development of science teachers is directly related to the students' science affinity. As teachers develop their pedagogical and content knowledge, they can also update their practical work and prepare their students for different high-school competitions (Alonzo et al., 2012; Kang et al., 2013). The well-prepared and up-to-date science teachers reflect their own experience and knowledge through practical work (Manning & Payne, 1993; Sanger & Osguthorpe, 2011). Recently, many schools have updated their teaching practices to make teachers actively share their knowledge and implement their instruction through experimentation (Stoll et al., 2006). The new reform-oriented pedagogical approach strongly correlates with the implementation of practice within a science teacher's classroom and converts that into practical applications such as projects (Aguirre & Speer, 2000; Datnow & Castellano, 2000; Deemer, 2004; Gess-Newsome et al., 2003; Pajares, 1992;

Roehrig et al., 2007; Woodbury & Gess-Newsome, 2002). From all these changes, students get the utmost benefits by being attractively engaged in STEM, but also teachers take their part by becoming an integrated teacher into the present century (Bencze & Bowen, 2009).

The purpose of the present work is to study the outcomes of participation in science Olympiad on students and teachers of a multiethnic post-conflict society. The participation trends between genders and ethnic groups over the years are studied. Moreover, the impact of a science activity on students' careers, socialization, and students' self-confidence, were as well addressed. This paper is indicative of how a practical science project organization can improve science education, demonstrating a model work to successfully promote science in post-conflict settings. The following research questions were assessed relevant to the purpose of the study:

Research Question 1: How is the relation between student's gender and the categories in which they competed?

Research Question 2: How did participation in the science Olympiad affect high-school students' careers?

Research Question 3: How does a science Olympiad contribute to inter-ethnic communication?

Research Question 4: How does participation in a science Olympiad affect self-confidence in students?

Research Methodology

Setting and Choice of Competition

The Bosnia Science Olympiad (BSO) is the first national Science Olympiad in Bosnia and Herzegovina. It started in 2012 to improve science

education and bring different inter-ethnic groups under the umbrella of science, in a post-conflict area. The language of the competition was English and all students were ESL. The aim was to reach all high schools over the country, irrespective of their ethnic and religious community:

“The aim of this project isn’t just developing the consciousness of the participants for science and scientific work, but also to allow high school students to meet their peers from all across Bosnia and Herzegovina (Bosnian Science Olympiad 2016 Gathered High Schoolers From All Over Bosnia and Herzegovina, 2016)

It was designed as a two-day endeavor held in Sarajevo, Bosnia and Herzegovina. The program was set to include social activities as well. The awards for the first prize winners were gold medals, 21,000KM (~10,000 €), and 100% university scholarship, for the second prize a silver medal, 17,750KM (~9,000 €),

and 75% university scholarship were awarded, and the third prize winners received a bronze medal, 10,500KM (~5,000 €), and 50% university scholarship. The Science Committee comprised of members from different universities, experts in their fields—science, engineering, and social studies. The calendar of events, the evaluation criteria of the projects (Appendix 1), the advancement of organization, and the educational seminars were all coordinated by this Commission.

Demographic Characteristics of Participants in BSO

The data of participants’ gender and the category they competed during the 2012-2016 period are analyzed using descriptive statistical methods (Table 1). Students from main cities such as Sarajevo, Mostar, Zenica, Tuzla, Bihac, Brcko, and Velika Kladusa, participated every year starting from 2012. Smaller cities and towns joined over the years (Figure 1.A).

Table 1.

Participation of students according to their gender and their project category in the 2012-2016 period

Total student numbers in projects										
Gender	Web Design		Environment		Have an Idea		Engineering		Total	
	n	%	n	%	n	%	n	%	n	%
Male	107	21%	98	19%	97	19%	205	40%	507	63%
Female	10	3%	134	44%	122	40%	37	12%	303	37%
Total	117	14%	232	29%	219	27%	242	30%	810	100%

Year	Project Categories									
	n	%	n	%	n	%	n	%	n	%
2012	8	17%	20	42%	10	21%	10	21%	48	9%
2013	30	18%	48	28%	44	26%	48	28%	170	33%
2014	23	23%	19	19%	27	27%	31	31%	100	19%
2015	18	18%	17	17%	33	33%	32	32%	100	19%
2016	15	15%	22	22%	33	33%	30	30%	100	19%
Total	94	18%	126	24%	147	28%	151	29%	518	100%

Only high-school applicants aged 14 to 18 were allowed to apply. Although in the first year almost all projects were accepted as finalists, in the second year selection was applied to increase the competitiveness (Figure 1.B).

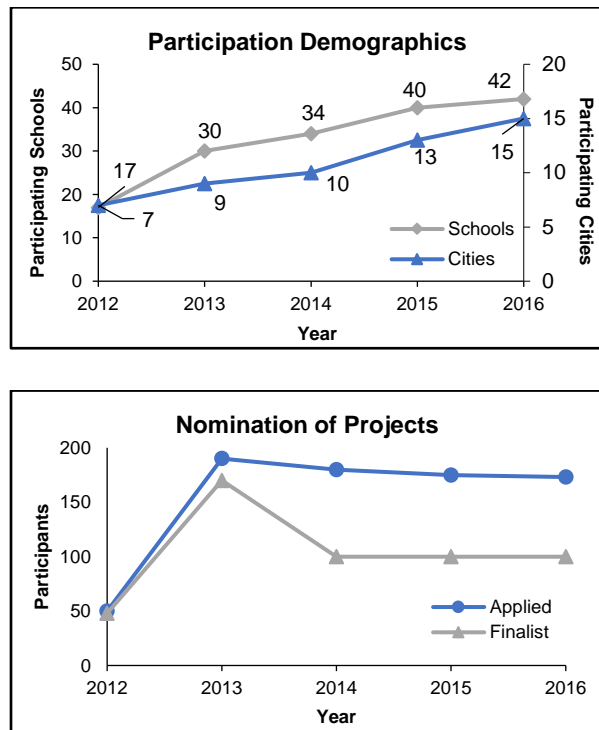


Figure 1. A. The number of cities and schools participating in the Bosnian Science Olympiad (BSO) each year B. The number of applied and finalist projects in BSO over the years.

To be enrolled in the competition, students were expected to develop a new project employing novel ideas, under one of four possible categories (Table 2), have a supervisor, and pass the preliminary selection to become a finalist.

Table 2.

The competition categories in Bosnia Science Olympiad (BSO)

Category	Topics included
Environment	Water quality, air quality, recycling, soil and forests, food and agriculture, animal protection, health care, and the use of pesticides.
Engineering	Electronic and mechanical work, energy efficiency, novel devices, robotics, new applications, embedded systems of electronics, and computer programming
Have an Idea	Social and educational ideas, cultural activities, psychology and mental health, teenager problems, language abilities, and economic approaches
Web Design	Web design algorithms, web applications, applications of mobile technologies, and the applications of web design in the classroom

Data Collection and Analysis / Instruments

The data used in this study were collected using different methods. Demographic data was acquired from the application forms that students submitted when they applied to the Olympiads. The head of the organizing committee, Dr. Senol Dogan, carried out the interviews with teachers and executive administrators. Each interview lasted about 20min using the questions shown in Appendix 2. Notes taken during the verbal interviews were presented to the subjects for approval. Students completed questionnaires themselves (Appendix 3). Questionnaires of administrators and students were analyzed by descriptive statistics, based on the research questions. Consent was taken to publish the data.

Research findings and Discussion

Plateau in a Science Olympiad Organization

In 2012, BSO started with 48 projects presented by 78 students from 17 schools. The number of projects, participants, and cities increased steadily each year in the 2012-2016 period (Figure 1.A). BSO 2014 was characterized by increased participation and with the Olympiad becoming standardized in all organization stages. The two-year journey of the Olympiad under the governance of the Science Committee, reached a plausible level to nurture the future science professionals. The demographic distribution of the participants shows that the Olympiad was accepted by students of different schools and communities and that it has extended its reach across the country (Figure 1.A). From 17 main cities in the country, 10 (~59%) were presented in the third year and 15 (~88%) in the fifth year of its organization. The number of participants increased from 78 to 143 and of schools from 17 to 42. During the first five years of BSO, the overall number of participant students, cities, and schools show a steady increase (Figure 1A. and Table 3). The number of finalists, however, was set to a constant number by the Science Committee to ensure a more competitive environment (Figure 1.B). The number of projects from each category was set to 25 and a total of 100 high-quality projects were nominated starting from 2014. This increased the competitiveness among the students and indirectly the quality of the Olympiads.

Participation and Competition Category Choice

by Gender

Regarding the total male/female ratio, there is a notable increase over the years. The male/female ratio

started from 1.23 in 2012, and five years later increased to 1.60 (Table 3 and Figure 2.A).

Table 3.

Gender distribution of participants over years.

Year	Male		Female		Sum n	Male/ Female Ratio
	n	%	n	%		
2012	43	55%	35	45%	78	1.23
2013	15	59%	11	41%	26	1.41
2014	7	%	1	%	8	1.32
2014	14	57%	11	43%	26	1.32
2014	9	%	3	%	2	
2015	93	60%	63	40%	15	1.48
2015	6	%	6	%	6	
2016	88	62%	55	38%	14	1.60
2016	3	%	3	%	3	
Mea	10	58%	75	42%	18	1.41
n	6	%	75	%	1	

The analysis of the relationship between gender and the selection of a category, on the other hand, shows a pronounced difference. Of all male participants, 21% competed in the Web Design category, while from female participants only 3% did the same (Figure 2.B).

The engineering category constituted the favorite category of males, with 40% of them choosing it when compared to 12% of the females. Furthermore, the distribution patterns show that there is a preference of females to “Have an Idea” and Environment categories (Figure 2.B). In our study, we found that few females chose to compete with an engineering project. This is consistent with earlier findings where only about 21% of females (USA national engineering trend as studied by Yoder in 2016) receive a degree in engineering. This clearly shows a bias of female students starting from high-school and following them in their careers. To bring more women to an engineering career, teaching professionals should pose a solution that is effective during the secondary level of education (Yoder, 2016).

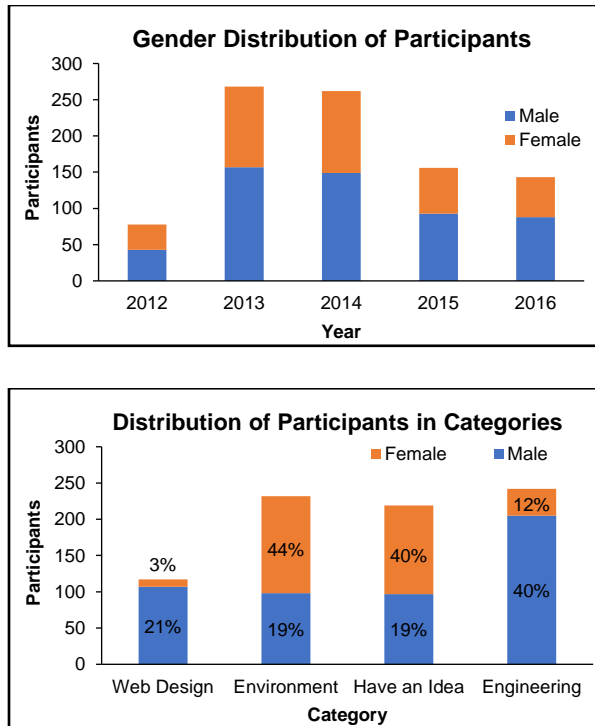


Figure 2.A Gender difference in students participating in BSO over years B. Gender difference distribution in categories.

Qualitative investigation shows that students benefit from participation in BSO in many different ways. They gain new experiences, aim science in their academic careers, get socialized, communicate without prejudices, show improvement in self-confidence, broaden their global vision, etc. The main outcomes are described under three themes that will be explained as follows. The themes were deductive decided and based on research questions two, three, and four.

The Contribution of BSO to Student's Academic Careers

Olympiads developed into a new worldwide trend of promoting and improving the quality of science education (Grevtseva et al., 2018). The first and foremost result of any Science Olympiad has been to

increase the quality of science education by using the empirical way to provide a bridge to the theoretical knowledge (Sahin et al., 2015). Observation of everyday life and converting that into practical work with a group of students and their science teachers is the best way to learn and remember. *Adna Sijercic*, a competitor in BSO 2012, used the following statements to show how BSO changed her academic goals:

“I was a participant in the first Burch Olympiad, and it was of great importance to me and my future to choose science, which I have been studying since then. I went to Veterinary High School, and I wanted to be a veterinarian, but I applied for the Burch Olympiad with a genetics project in the Engineering category in 2012. I won the silver medal and a 30% scholarship, and after that experience, I knew I wanted to study in that faculty. So I think the Burch Olympiad is a fundamental way to show young people what to study and to help them to make that all-important decision. Moreover, it is a great way to meet other students and professors and see other ideas and opinions as a high school student. Burch Olympiad is essential, and it is a great experience that I think all prospective high school students should experience at least once. Now I am actively doing microbiology research at the university.”

Muhamed Hajlovac, explains the course of changes for him after participating as a student in BSO:

“I am the winner of the Burch Olympiad 2015 in the Environment category, with a project

entitled “Nanocrystal solar cells”. The idea was to use plant receptor pigment anthocyanin to enhance the capabilities of the solar cell. The Burch Olympiad was a unique place to present this idea, but also to meet other high school students and learn about their ideas too. Winning assured me of a scholarship at Burch University, and so it changed the course of my life. Since then, I have been a student of genetics and bioengineering at Burch University.”

Valuable Projects Produced by the Competing Students

The other outcome of BSO is the long list of valuable projects produced with limited sources. Students have used what is readily available to them as materials together with local products to produce their projects. For example, one project that stands out in the Environment category uses fruits as a natural antibiotic by combining it with the bacterial agar and eco-detergent to make a completely natural soap bar (Appendix 4). Another interesting project was the Robotic Hand project designed to help people who lost a hand during a mine explosion, which is a widespread occurrence in Bosnia Herzegovina. The Mud Charger and Hydrogen Core Reactor projects are other examples of influential Engineering projects which attracted the interest of some companies for development and have already been bought. The Web Design and “Have an Idea” projects are mainly social-related, observational, theoretical, and survey research. The School Management System and the Smart Class are examples of Web Design projects. The Solar Charging Station and Power-house were selected as the best theoretical projects with the best possibility of being turned into viable future products.

“Have an Idea” category is composed of mainly social and human behavioral projects, for example, how to stop Internet addiction and hooliganism among high-school students, which were both highly appreciated by the Bosnia Herzegovina Ministry of Education. Color remedies for human psychology and sleep disorders are another two outstanding projects. Due to the high quality of the projects presented, academics and companies from the business world have offered to collaborate with the students and help them to further develop the projects either at university as research or for a company to produce the product. As the dean of the Engineering Faculty of Burch University Assoc.Prof.Gunay Karli noted (an administrator of BSO at the same time), many industrial companies were attracted to the student projects by a strategy of naming startup company representatives as a jury member, one in each judging team. According to him, one of these examples were student projects got the attention of the companies was the project of Dalibor Durmic who competed in the engineering category in BSO 2014 and was accepted as a startup project in Siemens AG.

The Contribution of BSO to Socialization and Inter-ethnic Communication

The war trauma follows Bosniaks in the post-war days of peace. Reconstruction of the economy and the recovery of family life did not solve all the reconciliation issues that seem to require a rather complex set of essential changes. The direct effect of education in reconciliation by forming an educated workforce that is capable of making changes should be complemented with a secondary effect of diminishing the inter-ethnic hatred (Coles, 2011). Education can achieve this by bringing students of different ethnicities together around the same desk, aiming the

same tasks. This, in turn, can foster new generations that do not have the same prejudices as their war-experienced parents.

Bosniaks being the largest ethnic group in Bosnia and Herzegovina (50.1%), in five years of BSO organization had participation ranging from 60 to 70% (Table 4), showing a close relation to the overall situation in Bosnia and Herzegovina (Europe, Bosnia and Herzegovina, The World Factbook - Central Intelligence Agency, 2020).

Table 4.

The five year total of ethnic make-up in BSO (2012-2016 period)

Ethnic Group	Min		Max	
	n	%	n	%
Bosnian	544	60	634	70
Croatian	227	25	272	30
Serbian	91	10	136	15

Serbs present with 30.8% in the country, over five years in BSO they participated in a range of 10-15%, and Croat students participated with 25-30%. All these different communities during the Olympiad days played together, collaborated, and ate and drank together. The peaceful environment contributes to the missing reconciliation throughout the country. As noted during student interviews, the positive relationship between the students in a multiethnic platform spreads to parents, families, and all over the community. This nurtures the development of the society. As there is an absence of consensus for a single way to remove the obstacles between the ethnic groups in a post-conflict area (Dupuy, 2008), we propose integrating Olympiads in the education systems of such countries as a powerful way to

promote communication between inter-ethnic communities.

Dalibor Durmic, another student participant, explains how BSO contributes to socialization in his country:

“There are many reasons why the Bosnian Science Olympiad is ideal for our country. I will single out some of the most essential points: getting to know students from other high schools across the whole of BiH, to promote your projects and networking with professors from different universities, and the fact that it gives you a higher chance of winning a scholarship. This is an excellent opportunity that will surely change your life for the better because you will definitely get the support and your ideas will not remain unheard. The diversity of people is something beautiful, and that is why we have to take all the people around us for what they actually are, with all their faults and virtues no matter what their ethnicity. We are all different from one another, we are all unique and perfect in ourselves, and we are just as we should be, but we are primarily meant to be different. So let’s accept others around us because we can discover many exciting things through them that we could not discover alone, and this is precisely because of our diversity.”

Faruk Ćidić, another participant student, shows how students widen their horizons and remove their barrier with the following sentences:

“The Bosnian Science Olympiad is a perfect opportunity to present the solutions to specific local or global problems in all spheres of life. The organization is an

excellent opportunity for young people to present their innovative projects, ideas, and inventions, to further develop their solutions. The Bosnian Science Olympiad, which brings together a large number of young people from all over Bosnia and Herzegovina, with its combination of Science and friendship breaks all barriers and even post-war hatred and encourages peace and unification.”

The Contribution of BSO to Increased Self-Confidence in Students

As noted during the student interviews, there were moments during the special events in Olympiads that produced a particular impact on student’s self-confidence. They felt honored and privileged during their meetings with the professional jury members (who were the top-tier scientists in their fields), during the opening and award ceremonies where the country’s Minister of Education addressed his speech towards them, and during the certificate presentation by the Ministers in front of their supervisors and school administrators. An additional confidence-improving factor was the participation in a US Embassy-supported Olympiad, as noted by the students in the survey.

Limitations

The work presented has limitations. Firstly, if a pre-administered survey would be done, we would have a

comparative study on how the perceptions changed before and after attending the Olympiad. Secondly, a five-year later follow-up student survey would serve to see how Olympiads affected their career and if the communication with students of different ethnicities continued. Lastly, jury and parent interviews were missing. This may give additional information on aspects not covered in this work.

Conclusion

This work demonstrates a model work to successfully promote science in post-conflict settings. After drawing the framework of a successful Science Olympiad organization, we analyzed the outcomes of it in improving science education and bringing different inter-ethnic groups under the umbrella of science in a post-conflict area. The increased level of science careers in students of high-school, their improved socialization and self-confidence, motivate all in-charge stakeholders to work more to provide these opportunities to more students. As a future vision, the Bosnian Science Olympiad aims to become a bridge between the great ideas of students and real-life projects. This can be achieved by finding partners from the industry that can bring ideas to life. BSO is working to achieve this by providing a meeting point, an incubation space, for students and industry.

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Appendix

Appendix 1

The judging criteria of projects in the Bosnia Science Olympiad

Criteria	Explanation	Pts
Creativity/Originality	Originality of the problem; unique approach to solve a sustainability issue.	10
Review of Literature	Research of scientific literature and use of references.	10
Scientific Thought	Statement of hypothesis; clarity of purpose; identification of all relevant variables.	10
Scientific Method	Evidence of depth of study and effort in employing scientific procedures; proper methods followed for experimentation and investigations.	10
Data Management	Proper recording and display of data in tables, charts, and graphs; proper analysis of data.	10
Conclusions	Drawing logical conclusions, consistency of conclusions with obtained data; recommendations for further research.	10

Applications	Practical applications of the project; benefits for society in certain ways.	10
Research Skills and Effort	Level of skills and effort by (each) researcher to carry out the project; amount of work; high level of understanding of the techniques and equipments used to gather data.	10
Understanding the Project	(Each) Student's understanding of each step during the implementation of the project.	10
Quality of Display	Well organized display; project journal.	10

Appendix 2

Administrator interview questions

1. The Bosnia Science Olympiad is organized to bring together students from different ethnic backgrounds. How do you evaluate the contribution to the communication between different ethnic communities?
2. How do you organize your teachers and students to compete in this Olympiad?
3. There are social activities organized during the Olympiad where students perform music, dancing etc. What is the contribution of your school to support these events?
4. In the previous years there were laptops and money awarded to administrators in order to better motivate the school teachers and students for participation. According to you, what kind of award is better to achieve this, and why?
5. In which aspects do you think these organizations help the advancement in Bosnia and Herzegovina?

Appendix 3

Student Questionnaire

1. How did you prepare for the competition?
2. How did you feel to participate in the same competition where all ethnic groups are competing together?
3. How did your thoughts change on working together with people of different ethnic background after the competition?
4. How did your future plans about your career change after attending the Olympiad?
5. How would you compete the next year in this Olympiad? Would you prefer to improve your project or do a new one in a different category?
6. What motivated you the most during the Olympiads?

Appendix 4

Sample projects

Environment Category	Explanation of Project	Type of solution
Reduction of plastic waste by using plastic	Using plastics to degrade plastics with different ideas and application	Practical
Disposal and recycling of waste materials	Using waste material from collecting to reusing	Practical
The Economic home	New and novel applications to make a home economical	Interdisciplinary
Eco Soap	The hand production of an eco-soap using plants endemic to BiH	Practical
Water transport by steam	Steam transportation using a water system	Mini test
The effect of spice on bacteria in food	The application of different spices to colonies of bacteria	Practical
Cleaning the ocean with bio-motion	Collecting oil droplets using magnetic balls	Practical
Solar water desalination	Separating the salt from water using the power of the sun	Practical
Photovoltaic solar collector	The application of solar photovoltaic devices for the home	Practical
Engineering Category	Explanation of Project	Type of solution
Machine vision	Increasing the vision quality of a machine	Practical
Tesla Coil - Powerless transmission	Transmission of energy without the use of a cable	Theoretical
Hydrogen Core Reactor	A Hybrid engine using hydrogen	Applicable
Mud charger	The application of a simple mud charger to be used with some devices	Practical
Robotic Hand	An artificial hand for a person who has lost their hand in a mine explosion	Practical
Underwater turbine	Using water power maximally underwater	Ideas
Monitor It: Surveillance Application	A new surveillance system for companies and homes	Practical
Wireless program	An efficient wireless system	Theoretical
Smart Cam security system	Alert, detection and interpretation of security problems	Practical
Web Design	Explanation	Type of solution
"Smart Class" online register book	To stop mistakes in writing notes by hand in a notebook in class	Practical
eStudent	Online student success by controlling school educators	Application
IWP - Interactive Web Presentation	Home to home interactive presentation of homework or ideas	Application
School management system	A novel school management system	Observation
Smart Street Lights	Controlling street lights automatically using the Internet	Application
Solar charging station	Application of some solar charging stations in shopping malls and cafes	Observation
Power-house	The distribution of water, wind and solar power systems	Theoretical
Multiplex Platform	To let several phone calls happen at the same time	Practical
School Touch	Online follow-up activities at school	Practical- Test
Have an Idea	Explanation	Type of solution
Nature in Numbers - The Impression of Perfectivity	Finding and presenting the relation between nature and mathematics	Observation
Increasing consumer awareness in BiH	To support and make the citizens of BiH aware of their consumer rights	Survey
Automatic follow-up of student absence	Student absence and parent reporting using a face recognition system	Interdisciplinary
A colorful taste in healthy colors	How colors affect people's psychology and health	Survey
Addiction to the new era of the Internet	Addiction to the Internet and the potential future psychological problems	Test-Observation
Hooligans OUT, Fair Winding IN	Reduction of incidences of hooliganism? Fair-play in school tournaments	Test-Application
Parking Solution	Novel ideas for city-center parking solutions	Theoretical
Stabilizer for a camera	A gadget to stabilize a camera	Practical
Natural remedies for better sleep and concentration	A novel application to solve sleep disorder and concentration problems	Practical-Test

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