EDU-ARCTIC COMPETITIONS AS AN EFFECTIVE WAY TO INCREASE STUDENTS' INTEREST IN STEM

A. Goździk[1], L. Mortensen[2], T. Jończyk[3]

[1]*Institute of Geophysics, Polish Academy of Sciences (POLAND)*
[2]*Jardfeingi (Faroe Islands Geological Survey) (FAROE ISLANDS)*
[3]*Adam Mickiewicz University, Faculty of Educational Studies (POLAND)*

Abstract

Competitions combined with field trips organised for students and teachers break the common format of teaching and learning in which knowledge is transferred in traditional way at the premises of schools. Science trips are innovative methods of making the learning processes more attractive and appealing. Moreover, competitions for students may stimulate students' creativity and help to increase their inventiveness. An educational initiative proposing contest for students combined with attractive prizes of polar expeditions is EDU-ARCTIC.

EDU-ARCTIC is a Pan-European initiative available for secondary schools, which uses the Arctic and polar research as a vehicle to encourage pupils aged 13 to 20 to pursue further education in science, technology, engineering and mathematics (STEM), setting them on a path to careers in one of these sectors, or even to become a scientist. Students participating in the project have a unique possibility to get to know what scientific careers are like and to learn more about different research disciplines while learning how to apply the scientific method. It aims to establish strong links between the research and education communities by connecting schools to scientists working in various places of the world. The EDU-ARCTIC project uses a mix of different tools for teaching STEM, including online lessons with scientists dealing with polar research, environmental monitoring program, and Arctic Competitions with a chance for students to win a trip to an Arctic research station.

In this paper we present information on organisation of the EDU-ARCTIC Competitions, winning projects from three editions and evaluation studies on the contest's impact on participating students. We also demonstrate how the EDU-ARCTIC contest and polar expeditions are related to one of empirically verified models of effective teaching (so-called PERMA).

Keywords: secondary education, STEM, competition, arctic environment, polar regions, outside classroom activities, PERMA model.

1 INTRODUCTION

Competitions combined with field trips organised for students and teachers break the common format of teaching and learning in which knowledge is transferred in traditional way at the permisses of schools. Science trips are innovative methods of making the learning processes more attractive and appealing. When science excursions are combined with cognitive learning approaches [1], they can: increase students' exposure to unfamiliar environments and hands-on real-world experiences; provide assistance integrating theoretical and practical concepts, engage students in science and increase their motivation; introduce abstract topics and higher-level concepts in an easily understandable manner; improve socialisation among students, and between staff and students.

Moreover, competitions for students may stimulate students' creativity and help to increase their inventiveness. EDU-ARCTIC Competitions aimed to increase interest of students in STEM and encourage them to take up a scientific career in the future. The other important objective was to promote arctic research in polar and subpolar regions in order to equip students with knowledge about the challenges that natural environment and societies face in the Arctic. In this paper we present information on organisation of the EDU-ARCTIC Competitions, winning projects and evaluation studies on the contest's impact on participating students.

One of empirically verified models of effective teaching is the so-called PERMA. The model of support for pupils and teachers designed by Martin Seligman is based on 5 pillars: Positive emotions, Engagement, Relationships, Meaning and Achievements. In the following parts of this paper, we demostrate how the EDU-ARCTIC contest and arctic expeditions are related to PERMA.

2 EDU-ARCTIC EDUCATIONAL PROGRAM

2.1 EDU-ARCTIC educational program

EDU-ARCTIC is an EU-funded project focused on using Arctic research as a vehicle to encourage pupils aged 13 to 20 to pursue further education in science, technology, engineering and mathematics (STEM), setting them on a path to careers in one of these sectors, or even to become a scientist. Pupils participating in the project have a unique possibility to get to know what scientific careers are like and to learn more about different research disciplines while learning how to apply the scientific method, and also to learn crucial problem-solving skills.

The project is conducted by six organisations: Institute of Geophysics, Polish Academy of Sciences (Coordinator, Poland), American Systems sp. z o.o. (Poland), The Norwegian Institute of Bioeconomy Research – NIBIO (Norway), Jardfeingi (The Faroese Geological Survey) (Faroe Islands), Universite de Versailles Saint-Quentin (France), The Arctic Portal (Norðurslóðagáttin ehf) (Iceland). The project, which is funded for 3 years, started in May 2016, whereas activities for schools started in January 2017. More than 1180 teachers from 58 countries have registered to the program.

2.2 The EDU-ARCTIC main components

The EDU-ARCTIC project offers a mix of different interactive, innovative tools to bring a fresh approach to teaching STEM subjects:

1 Webinars: Online lessons with polar scientists working at research stations and institutes. The lessons focus on natural science topics, polar research and why they are key to helping solve important challenges in society. In each online lesson up to 23 school groups may participate simultaneously. Webinars are conducted in English and in a few other European languages.

2 “Polarpedia”: An evolving online encyclopedia that contains a glossary of scientific terms in 16 national European languages (English, Polish, Danish, Norwegian, French, Icelandic, Romanian, Bulgarian, Italian, Greek, Bulgarian, Russian, Albanian, Croatian, Serbian, Macedonian and German so far). It helps teachers and pupils to prepare for their participation in webinars by providing short explanations of scientific terms used by researchers conducting webinars. It contains photos, graphics and animations or videos, if possible. It is divided into 9 categories: Ice & Snow, Climate & Weather, Plants & Animals, Land & Geology, Atmosphere, Water resources, Space, People & Society, Places & Stories. Moreover, additional part of Polarpedia contains educational resources to be used by teachers and students in form of online games, quizzes, worksheets, experiments, teamwork proposals and other.

3 Environmental monitoring program: All participating schools in Europe are invited to take part in the program to conduct environmental monitoring around their school. The program has a web-based interface allowing interested schools to report their observations in an open and accessible database. Additionally, mobile app was developed in order to enable students and other citizens to report on measurements conducted by them. The program is dedicated to meteorological and phenological parameters. Within meteorological observations and measurements there are reports on some actual values and reports on phenomena, which occurred since the last observation. Biological observations cover plants, insects, and birds monitoring.

An important part of the EDU-ARCTIC program are three editions of the Arctic Competitions, which are presented in detail in the next section.

3 EDU-ARCTIC COMPETITIONS

3.1 EDU-ARCTIC Competitions – general information

European pupils and their teachers were encouraged to take part in three editions of the Arctic Competitions, in which winners are invited to participate in the arctic expedition and in field work and scientific discussions. Arctic Competitions were proposed to all secondary schools from Europe, and in the second and third editions also to schools from the whole world. Participants of the competition were working in teams of one pupil and one teacher, whereas in the last edition participation of teams of two students and one teacher was also accepted. Each team developed an innovation or research

project in the form of essay, video or a poster. An international jury chose 4 to 6 winning teams per edition, who were invited on an Arctic Expedition to visit one of the stations participating in the project.

Within the EDU-ARCTIC project, three editions of a competition were organised in order to give students and teachers, who won the competition, a chance to join an Arctic Expedition to visit a polar station during school holidays. All through the stay, winners were given opportunity to act as scientists working at the station, taking part in measurements that are normally made at the station. They took part in presentations about scientific research carried out during their stay (eg. hydrology, magnetism of the earth, geological studies, oceanography, meteorology or polar issues). This was a unique opportunity for these young people to see the real work of a scientist in the field, an experience likely to impact their future studies and professional choice in an inspiring way. Special educational programs were prepared in advance for them to play an active role in the process. For instance, during the stay at the Polish Polar Station in Hornsund, winners had the possibility to explore Spitsbergen island and its glaciers in the neighborhood of the station, participate in hydrology measurements (which require pontoon cruises), participate in geological and geomorphological studies, make meteorological observations and do some monitoring, as well as take part in observations and biological measurements of Little Auk colonies. Winners joining the Arctic Expedition to the Faroe Islands had the possibility to explore the islands and visit various monitoring sites while participating in scientific work and mapping. The Faroe Islands is an archipelago of 18 small islands in the northeast Atlantic Ocean. Svanhovd in northeast Norway offers steep and short gradient suitable for studies, e.g. on climate, vegetation types and pollution effects, - the latter due to its location close to large emitters of SO2 and heavy metals; metallurgic industries in northwest Russia. Winners joining the Arctic expedition to Iceland were based in Akureyri, close to the Chinese-Icelandic Aurora Observatory. They learned about the geologically active rift zone, the active volcanism and its geothermal potential for the Icelandic society. They also had the chance to enjoy the spectacular Icelandic scenery on land as well as at sea. The latter included whale watching by boat and learning about the marine ecology in this part of the North Atlantic ocean located directly on the Arctic circle.

3.2 Organisation of EDU-ARCTIC Competitions

Competition rules were prepared and announced on the project website. The jury of the competition consisted of representatives of all consortium partners involved in the project. The competition was divided into 3 stages. All interested pupils with their teachers (playing a role of mentors) were invited to propose an application containing an idea of research activities to be conducted in the Arctic (research project) or innovation activities designing a prototype of a tool or system of relevance to the Arctic in broad terms (innovation project). At the first stage the abstracts of applications were reviewed by the jury and up to 50 applications were selected to the next stage. At the second stage full applications in forms of essays, posters or videos were assessed. 12-14 best ideas were chosen for further presentations during online discussions with the international jury, which were the last stage of the contest. After online interviews, jury chose 4 to 6 winning teams to invite them to participate in the Arctic expeditions.

3.2.1 First edition of the EDU-ARCTIC Competition (2017)

44 applications were proposed by teams from 5 countries: Greece (3), Italy (1), Poland (24), Romania (15) and Spain (1). All teams were invited to the second stage and 38 teams prepared full projects. At the 2. stage of evaluation jury selected 12 projects with the highest evaluation score, which entered to the finals and their authors were invited to online individual interviews. After interviews six winning teams from: Poland (4), Greece and Italy were invited for a 10-day long arctic expedition to the Faroe Islands or Iceland. Both expeditions took place in August 2017.

The winning projects are presented in the Tab. 1, whereas more information on the ideas proposed by winners is available on the project's website [2].

Table 1. List of winning projects – edition 2017.

Student's name	Age	Teacher's name	Country	Type of project	Project title
Wojciech Kromólski	18	Łukasz Dziarski	Poland	Research	The phenomenon of thermal conduction with reference to life and human economy in the circumpolar areas
Julia Grabarkiewicz	15	Aleksandra Lipnicka	Poland	Innovation	SOS backpack tent
Angelica Perghem	19	Giulia Bagnara	Italy	Innovation	Arctic: a site for a new beginning. From cooperation to science
Jan Makowski	14	Piotr Malesa	Poland	Research	Immunity against infections in Arctic region compared to Central Europe region.
Aleksandra Sobańska	16	Liliana Skrycka-Kuźniewska	Poland	Research	Does water(ice) bloom in the Arctic? The influence of chosen factors on water bloom in the Arctic
Vassiliki Deligiorgi	16	Stelios Anastassopoulos	Greece	Research	Sheep's behaviour and activity in Summer

3.2.2 Second edition of the EDU-ARCTIC Competition (2018)

In the second edition of the EDU-ARCTIC Competition 160 applications were proposed by teams. The very high increase in number of applications (364%) indicates great interest of teachers and students at such activities. In the second edition participants were from 19 countries: Albania (18), Belgium (6), Brazil (1), Faroe Islands (5), France (10), Germany (1), Greece (34), Italy (1), Macedonia (1), Poland (10), Portugal (1), Romania (19), Russian Federation (1), Serbia (2), Slovenia (2), Spain (27), Sweden (7), Turkey (1) and United Kingdom (2). 50 applications from 13 countries (Belgium, Faroe Islands, Germany, Greece, Italy, Macedonia, Poland, Portugal, Romania, Russian Federation, Spain, Sweden, United Kingdom) were invited for the 2. stage. In the 3. stage 12 teams from Greece, Belgium, Poland, Russia, Spain and Faroe Islands reached the final and were competing to be selected as winners. The results of the second edition were announced in May 2018 and the expeditions took place in August 2018. The winning projects are presented in the Tab. 2, whereas more information on the ideas proposed by winners is available on the project's website [3].

Table 2. List of winning projects – edition 2018.

Student's name	Age	Teacher's name	Country	Type of project	Project title
Triantafyllia Vaiopoulou	17	Stelios Anastas-sopoulos	Greece	Research	Chemical comparison of the coastal flora between basaltic and non-basaltic landscapes of Svalbard
Javier Sánchez-Bonilla Martínez	14	Jose Francisco Romero Garcia	Spain	Research	Is Arctic haze still present, in smaller quantities, in summer?
Glyceria Mpouki	16	Stelios Anastas-sopoulos	Greece	Research	The genetical basis for Tardigrada's durability in the Arctic
Judith Plaza Ortuño	17	Jordi Escofet Miró	Spain	Research	Can we know our latitude with gravity and earth's magnetic field?
Pablo Gómez Toribio	16	Francisco José Gómez-Senent	Spain	Research	Estimation of relative humidity in the Arctic from the variation of the land surface temperature.
Kacper Markiewicz	17	Eliza Golańska	Poland	Innovation	Shoes with crampons

3.2.3 Third edition of the EDU-ARCTIC Competition (2019)

In the third edition of the EDU-ARCTIC Competition teams of two students-one teacher and one student-one teacher were allowed. Within 73 applications proposed in the third edition, 32 (44%) were prepared by teams of two students. There were 36 innovation projects and 37 research projects. Participants were from 18 countries: Albania (6), Belgium (4), Brazil (7), Croatia (1), Cyprus (3), Faroe Islands (1), Greece (24), Hungary (1), Lithuania (1), Macedonia (2), Poland (6), Portugal (1), Romania (6), Serbia (1), Slovenia (1), Spain (4), Turkey (2) and United Kingdom (2). 50 applications were invited for the 2. stage. In the 3. stage 14 teams from Greece, Belgium, Poland, Slovenia, Northern Macedonia, Spain and Romania reached the final and were competing to be selected as winners. The results of the third edition were announced in April 2019 and the expeditions are planned to take place in July 2019. The winning projects are presented in the Tab. 3.

Table 3. List of winning projects – edition 2019.

Students' names	Age	Teachers' names	Country	Type of project	Project title
Thomas Wielfaert	16	Ines Tavernier	Belgium	Research (Individual)	Can nanoplastics be found in sea ice?
Katarina Ahlin Rezar	16	Jose Francisco Romero Garcia	Slovenia	Research (Individual)	Heavy metals in bears fur
Vakrinou Annelia	15	Eirini Siotou	Greece	Research (Individual)	The effect of UV radiation on the leaves of Valerian plants
Judith Zaragoza López, Tarik El Aichouni Jouied	16	Jordi Escofet Miró	Spain	Innovation (Team project)	Helios' journey

3.3 Organisation of the EDU-ARCTIC Expeditions

Very important part of the Arctic Competition are expeditions to polar stations and institutions involved in the EDU-ARCTIC program. Each expedition was planned in detail in order to provide participants with opportunities to learn from scientists by participating in their work and field studies and visit many places to learn about landscapes, geology and terrestrial/marine ecosystems, as well as environmental issues. Some cultural aspects were also taken into account.

3.3.1 Expeditions in 2017

Two Arctic Expeditions were organised in 2017: to the Faroe Islands and to Iceland. First group of participants arrived in the Faroe Islands by plane and stayed in Tórshavn while visiting various other locations in the Faroe Islands. The winning teams visited many localities, where they travelled by car, by ferry and by helicopter. They visited many of the islands Streymoy, Eysturoy, Skúgvoy, Sandoy, Suðuroy, Borðoy and Vágar. In these locations, they did field work at geological sites revealing present active processes in the nature and the geological history the past 60 million years. They did a lot of short hiking and took part in boat trips and a helicopter ride.

Second group of participants visited Iceland and had the opportunity to learn about a wide variety of natural phenomena, including auroras, geology and plate tectonics, the fascinating flora and fauna of Iceland (both terrestrial and marine ecosystems), and renewable geothermal energy production and utilization. They visited the Chinese-Icelandic Aurora Observatory (CIAO) in Kárhól, east of Akureyri, to learn about aurora and Earth's atmosphere. The geologically active rift zone in the northeast of Iceland near Lake Mývatn, where the North American and Eurasian tectonic plates are separating, was presented to them. They learnt about plate tectonics, volcanism, and the geological history of Iceland. They went to a geothermal power plant in the Lake Mývatn area, where they could learn how geothermal power is produced. In a dive center in Akureyri they could learn about the marine life in the fjord and further out in the Greenland Sea. An unforgettable experience was a whale watching expedition in the fjord, where Akureyri is located.

3.3.2 Expeditions in 2018

Two polar expeditions were organised in 2018: to Svanhovd station in the northern Norway and to Hornsund Polish Polar Station on Svalbard.

The first trip took place at Eastern Finnmark with main basecamp at NIBIO Svanhovd Conference Centre, located in Pasvik at Svanvik. Large varieties of habitats, including lakes, rivers, Barents Sea coast, forest, mires and mountains and alpine landscape were visited. The participants took part in activities of biology, climatological and environmental research projects. The participants experienced one of the parts of Europe that has the highest variation of climatic zones over short distance in an area where plants, animals and man arrived together after the melting of the glaciers. They also gained research knowledge as well as had discussions with the research teams about education, research systems and research life.

The second destination was Hornsund Polish Polar Station on Svalbard and station's surroundings. Winners were travelling by planes to Longyearbyen, and from Longyearbyen to the polar station by a speed boat. There were indoor activities - lectures and laboratory works, as well as outdoor activities - trekking, hiking, and climbing for sampling. Observations of atmospheric phenomena are conducted at the Station (including Earth's electric field, UV radiation and aerosol). There is a chemical laboratory, where students could analyse the chemical composition of surface and precipitation waters. There are also continuous records of Earth's seismology and Earth's natural magnetic field. A few field trips were organised, including trip into the glacier cave. During outdoor activities, students visited Baranowski Research Station, trapper's huts and Hans glacier. A boat trip on the Hornsund fjord were organised. This expedition gave participants opportunity to get acquainted with the work of a scientist in an attractive location, acquiring safe behaviour skills in the field, as well as insight into sampling preparation and performing scientific research. Moreover, Svalbard offers a unique and magnificent scenery, diverse and fascinating fauna and intriguing cultural heritage.

3.3.3 Expeditions in 2019

Two polar expeditions are planned for edition 2019: to Svanhovd station in the northern Norway and to the Faroe Islands. The programs of the expeditions will be similar to the previous ones.

4 METHODS OF EVALUATION OF THE IMPACT

4.1 CAWI surveys

Within the project assessment of impact of participation in the EDU-ARCTIC Competition on students' interest in STEM and knowledge about the Arctic is implemented. An observation sheet for teachers was prepared [4]. The technique used for collecting data is CAWI survey. CAWI (Computer Assisted Web Interviews) research technique is an interview in which participants fill in an online questionnaire or survey received via the Internet. Currently the CAWI method is one of the most popular and fastest-growing research methods [5]. Compared to other methods, with a sense of anonymity and the opportunity to participate in the study at a time convenient for the respondent, it allows to collect more accurate data. The sheet consist of questions about changes in pupils' behaviour, openness and scientific courage.

Within the first stage of three editions of the Arctic Competition all teachers, who participated in the contest were invited to fill in the survey, however it was not obligatory. The survey consisted of 5 content question and one field for suggestions and recommendations [4]. Questions concerned (1) understandability of the rules, (2) assessment of the substantive level and given requirements, (3) reaction of pupils, (4) impact of competitions on the growth of interest in STEM, and (5) impact on the level of knowledge about the Arctic. The results of this survey are presented in the section 5.1.

4.2 FOCUS Group Interviews

Additionally to CAWI surveys, participants of the expeditions in the first and second editions of the EDU-ARCTIC competition took part in the FGIs (Focus Group Interviews). FGI is an evaluation technique in the form of structured group interview. Each group receives the same set of questions, asked in an organised manner. FGI lasts 20-40 minutes. FGI provides research conditions more natural than individual interviews or survey methods. Interactions between participants are dynamic and delivered opinions often very spontaneous and therefore valuable. Literature regarding FGI clarifies all its rules, e.g.: participants recruitment, environment of carrying out, moderator's skill or analysing procedures (e.g.: [6]). Moderators created friendly and very open atmosphere and encouraged participants to answer the questions. All interviews were recorded and then analysed by an evaluator from American Systems (project partner).

Conclusions were divided into two main parts: conclusions about the project's activities and its influence on pupils' interests, motivation to learn and thinking about STEM and conclusions about organisation of the competition, criteria of evaluation, and schedules of the expeditions. The most important conclusions are presented in the section 5.2.

5 EVALUATION RESULTS

The evaluation of the solutions proposed within the EDU-ARCTIC project is crucial in order to assess its impact and to propose changes required by end-users, if necessary. The evaluation process in the project is ongoing. In this paper the full results of the evaluation of the first and second editions and partial results of the evaluation of the third edition of the Arctic Competitions are presented.

5.1 CAWI surveys' results

Teachers were requested to assess the reaction of their pupils to the Arctic competition and its rules. They were assessing in a 6-grade scale from very negative (1) to very positive (6) emotions. 17 answers were obtained in the first, 42 in the second, and 30 in the third edition. The results of these surveys are presented in the Fig. 1.

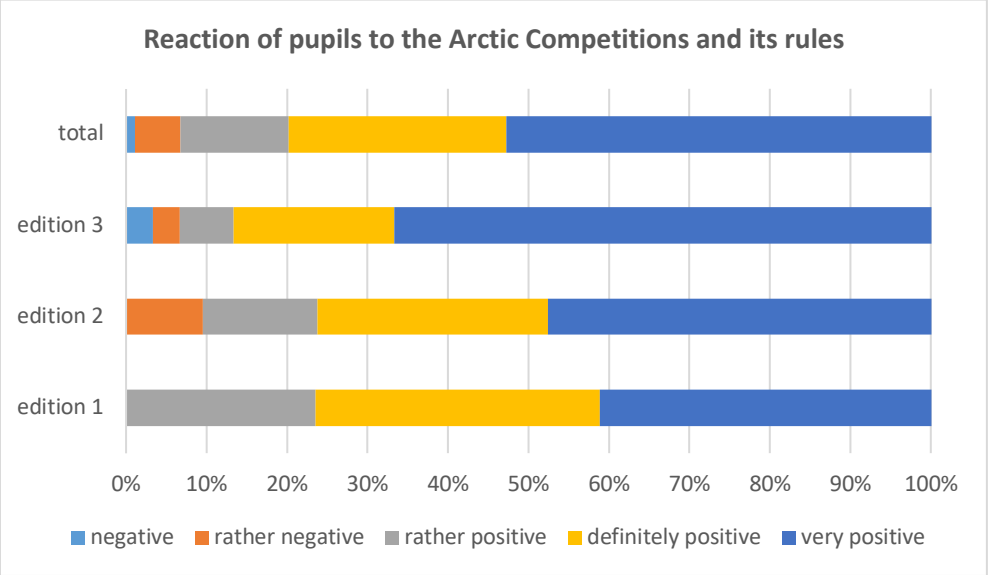

Figure 1. Reaction of pupils to the Arctic Competitions and its rules
(1. Edition – 17 answers, 2. Edition 42 answers, 3. Edition – 30 answers, total of 89 answers)

97% of teachers considered that the Arctic competition has a positive effect on the growth of interest in STEM among their pupils (16 out of 17 answers in the first edition, 41 out of 42 answers in the second edition and 29 out of 30 answers in the third edition), with respectively 11, 21 and 26 declarations of very strong effect. The results of this part of the survey are shown in Fig. 2, whereas the Fig. 3 presents the results concerning impact on pupils' knowledge about the Arctic. 99% of teachers thought that the Arctic Competition positively affected the level of knowledge about the Arctic among their pupils (75% considered it as a very strong impact).

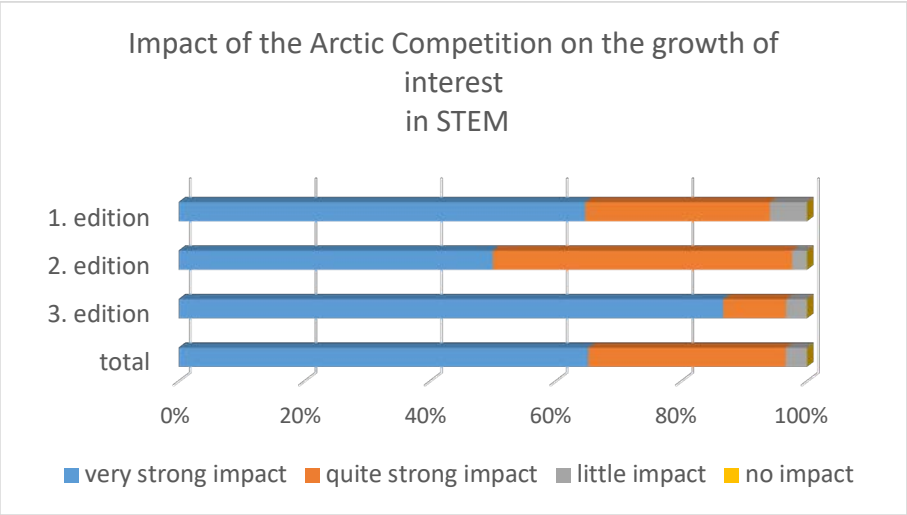

Figure 2. Opinions of teachers on the impact of the Arctic Competition on growth of pupils' interest in STEM and knowledge about the Arctic (1. Edition – 17 answers, 2. Edition 42 answers, 3. Edition – 30 answers, total of 89 answers)

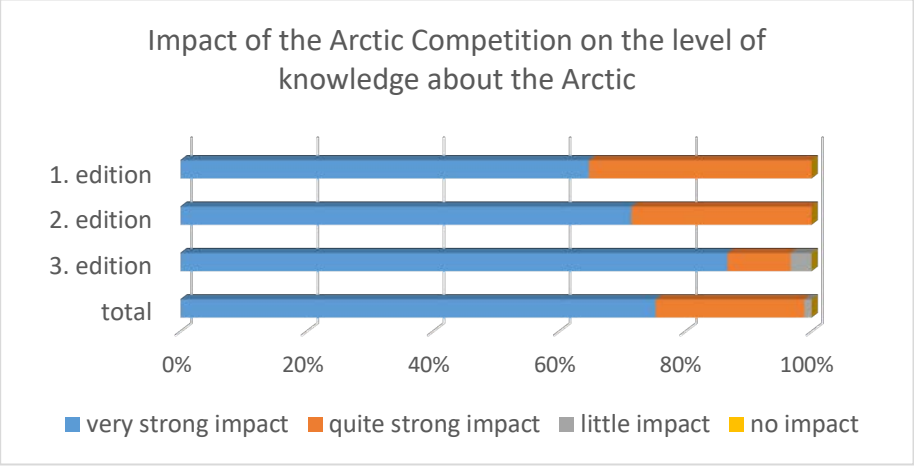

Figure 3. Opinions of teachers on the impact of the Arctic Competition on the level of pupils' knowledge about the Arctic (1. Edition – 17 answers, 2. Edition 42 answers, 3. Edition – 30 answers, total of 89 answers)

5.2 Conclusions from FOCUS Group Interviews

Conclusions were divided into two main parts: conclusions about the project's activities and its influence on pupils' interests, motivation to learn and thinking about STEM (subsection 5.2.1) and conclusions about organisation of the competition, criteria of evaluation, schedules of the expeditions (subsection 5.2.2). The most important conclusions are presented below.

5.2.1 Conclusions on impact on pupils

Teachers agree that EDU-ARCTIC project influences on pupils interests in STEM. They accented following aspects: Possibility to observe different research processes in vivo (during the expeditions); Direct contact with different nature phenomena; Practical implementation of rule: "learning by doing"; Possibility to transform knowledge into skills, in practical activities, Contact with new measuring tools and new technologies, used in scientific research, but also possibilities to talk with researchers. It was also underlined that during learning process at schools pupils often have to **believe** in what teacher says, but during such expeditions, pupils can **verify it –** they don't have to believe, they can check it.

In responders' opinion, projects like EDU-ARCTIC are motivating not only in STEM field, but also in language aspect. Teachers and pupils stressed, that being a part of this project gave an opportunity to excellence their English (also technical English) and a motivation to improve it.

Teachers and pupils appreciated also the technological aspect of the EDU-ARCTIC program. They have access to new educational methods, for example: on-line lessons; videos, which present pupil's project, but also modern methods of scientific information, which means, that teachers learn how to talk about science in a friendly way. They admitted that in an indirect way, the project could influence on pupils interests in scientific career: first, the project can cause greater interest in STEM, research activities, the process of hypothesis verification, etc. Thanks to that, a long-term result may be that students are inspired to consider a scientific career.

An additional benefit is the direct personal contact with other cultures. Building connections at this young age with people from other countries through science and innovation is an added value that was appreciated.

Opinions of pupils were very similar. No crucial differences were identified between the opinions of men and women.

5.2.2 Conclusions on contest's organisation

Participants of all four expeditions appreciated their programs, saying that they were attractive, interesting, and even outstanding. They proposed some organisational improvements. Detailed agenda of the expedition should be delivered to the participating groups, before an expedition. Thanks to that, participant would have a chance to prepare himself/herself. Regarding the organization of competition, some teachers and students from the second edition suggested that they would appreciate, if the projects could be prepared in groups, not by single students. Therefore in the third edition, organisers accepted participation of teams of two students and one teacher. Participants of particular expeditions should have similar English skills. It would help to create long-term relations.

6 DISCUSSION

The benefits of participation of pupils and teachers in competitions and trips proposed in the project seem to be clearly positive. However, they acquire additional significance if they are related to empirically verified models of effective teaching. One of them is the so-called PERMA. The model of support for pupils and teachers designed by Martin Seligman is based on 5 pillars: Positive emotions, Engagement, Relationships, Meaning and Achievements.

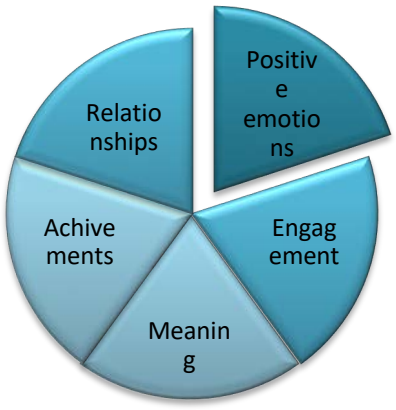

Figure 4. PERMA model of effective teaching (Source: own study, based on: https://ppc.sas.upenn.edu/learn-more/perma-theory-well-being-and-perma-workshops).

According to the results of empirical research, educational support that applies these 5 dimensions is very educationally effective (e.g. [7]). So how is PERMA model implemented within competitions and trips?

"Relationship" is a category referring to group based on similar values, goals and aspirations. If a young person has a chance to feel belonging, then it builds his/her motivation to activity. During competitions and trips, students can meet similar peers, talk to them and feel part of the group, which also includes teachers. During the few days of experience away from home, a sense of belonging to the international community is shaped.

The category "positive emotions" refers to such educational experiences that strengthen e.g. courage, curiosity, openness to experience. Participants of competitions have to face their own fear of assessment or fear of speaking in a foreign language and expedition participants often leave their home for the first time and set off thousands of miles from home. Such experience certainly builds a sense of competence and resilience.

"Engagement" is a category strictly related to the so-called location of control and source of motivation. Persons that perform activities to avoid punishment or gain a reward have externally located control, in contrast to people "controlled" internally, who choose given activities because of sense of satisfaction and fulfillment during its performance. Internally "controlled" people feel "absorbed" in situations that require the involvement of their skills [8]. Research shows that supporting pupils' sense of internal control over the educational process promotes the development of curiosity, sense of competence, readiness to take on challenges, self-assessment, but also contributes to better school performance [9]. The sense of "engagement" is strengthened by activities that are the choice of the pupil, not the result of educational coercion. Participation in competitions under the project is a voluntary decision of the pupil, involving a challenge and a huge amount of work. According to the theory, it is highly probable that it will build the sense of "engagement".

"Meaning" in the PERMA model is understood as the ability to perceive the connection between what an individual does and to what in some sense goes beyond itself and has significance for a wider context (local community, society, co-creation of the world, etc.). “Meaning” is a very individualized category - for one it will be meaningful to act for his/her own nation, for others to his/her family or school. During the EDU-ARCTIC project, its creators clearly emphasize the importance of care for the environment and all activities for the Arctic. In this way, the “meaning” of pupils’ activity during the project is built. The “meaning” that goes far beyond prize and a trip, but it is about human affairs.

“Achievements” are a source of knowledge about our competences, confirmation of our skills, but also a context in which we receive reinforcing positive feedback. According to the PERMA (and not only) model, each person has the potential to achieve its goals. It is obvious, that competitions are a great opportunity to confirm this assumption in practice.

Competitions and expeditions are only elements of the EDU ARCTIC project. It is worth stressing, the EDU-ARCTIC project implements PERMA model in practice in every single activity.

7 CONCLUSIONS

Evaluation of the Arctic competition shows that teachers find this tool as very effective or quite effective method of increasing interest of pupils in STEM. Almost all responders considered that the Arctic competition had very strong or quite strong impact on the level of knowledge about Arctic issues, and 97% of teachers assessed positively the impact of competition on the growth of interest in STEM. Therefore, we recommend including contests and field trips in school practice. It is also advisable to include activities of this kind in future proposals, projects and educational program of various types.

Moreover, other components of the EDU-ARCTIC educational program: online lessons, Polarpedia and monitoring system are available for all European secondary schools for free.

ACKNOWLEDGEMENTS

EDU-ARCTIC project has received funding from the European Union’s Horizon 2020 research and innovation program under grant agreement No 710240. The content of the document is the sole responsibility of the authors and it does not represent the opinion of the European Commission, and the Commission is not responsible for any use that might be made of information contained.

REFERENCES

[1] Alexandra Park Conference Centre, “The Benefits (and Challenges) of School Trips and School Camps” (Newsletter article), 2015. Retrieved from: https://alexpark.com.au/wp-content/uploads/2015/05/The-Benefits-and-Challenges-of-School-Trips-and-School-Camps.pdf, 2015

[2] Winners from the 2017 Arctic Competition, 2018, EDU-ARCTIC website. Retrieved from: https://edu-arctic.eu/news/99-winners-from-the-2017-arctic-competition,

[3] Close race as six teenagers win the EDU-ARCTIC competition 2018, EDU-ARCTIC website, 2018. Retrieved from: https://edu-arctic.eu/news/121-close-race-as-six-teenagers-win-the-edu-arctic-competition-2018.

[4] T. Jurńczyk, K. Man, “Evaluation plan including KPIs (key performance indicators)”, public report of the EDU-ARCTIC project, v2016. Retrieved from: https://edu-arctic.eu/library/project-reports/84-d-5-1-evaluation-plan-including-kpis-key-performance-indicators.

[5] H. Sharp, Y. Rogers, J. Preece, “Interaction Design: Beyond Human-Computer Interaction,” John Wiley & Sons, Inc. Huffman, LM 1996, *Processing whey protein for use as a food ingredient, Food Technology*, vol. 50, no. 2, pp. 49-52, 2002.

[6] R.M. Dilshad, M.I. Latif, “Focus Group Interview as a Tool for Qualitative Research: An Analysis”, Pakistan Journal of Social Sciences (PJSS) Vol. 33, No. 1, pp. 191-198, 2013.

[7] D.M Quinlan, N. Swain, C. Cameron, D.A Vella-Brodrick, “How ‘other people matter’ in a classroom-based strengths intervention: Exploring interpersonal strategies and classroom outcomes”, *The Journal of Positive Psychology*, pp. 77-89, 2015.

[8] J. Keller, F. Blomann, “Locus of control and the flow experience: An experimental analysis,” European Journal of Personality, Vol. 22, pp. 589-607, 2008.

[9] R.M. Deci, E.L Deci, „Self-determination theory: A macrotheory of human motivation, development, and health,” *Canadian Psychology/Psychologie canadienne, 49*(3), pp. 182-185, 2008.