HOW TO CONDUCT INSPIRING WEBINARS FOR STEM CLASSES IN SECONDARY SCHOOLS: EXPERIENCES FROM EDU-ARCTIC PROGRAM ON THE ARCTIC AND POLAR RESEARCH

A. Goździk

Institute of Geophysics, Polish Academy of Sciences (POLAND)

Abstract

Webinars for schools are an innovative tool, which helps to establish strong links between the research and education communities by connecting schools to scientists working in various places in the world. Webinars conducted by researchers allow to inspire pupils to engage in the learning process and to better understand the role of scientific research in the modern world, scientific messages and scientific language. They help to increase their knowledge about nature, geography, natural resources, history, social sciences, and political sciences and to raise awareness about environmental issues and climate change. They may also encourage young people to choose STEM careers, so crucial for the development of knowledge-based societies.

One of the projects using webinars to strengthen science education curricula across Europe is EDU-ARCTIC. 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 will 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 EDU-ARCTIC project uses a mix of different interactive, innovative tools to bring a fresh approach to teaching STEM subjects.

In the paper, various aspects of conducting webinars are presented. The author gave explanation, why the Arctic and polar research may be used as interesting and engaging topic for webinars for schools. Some advantages of this method were presented, but also potential barriers and problems, which may occur while proposing and conducting webinars, were discussed. The results of requirement analysis survey conducted among STEM teachers from secondary schools were presented. In the discussion various initiatives (EDUSCIENCE, ERIS, Scientix) were also indicated as a useful source of experience. The paper ends with a set of recommendations concerning preparatory of webinars, conducting a webinar and some technical aspects.

Keywords: STEM education, the Arctic, polar research, webinars, online lessons, environmental monitoring.

1 INTRODUCTION

Modern societies need an innovative science education which shall enable citizens to play a more active role in the Research and Innovation process. Through science education todays' pupils may learn how to make informed choices and to engage in a democratic, knowledge-based society. Science education allows us to interpret and understand our world, to manage risk and put uncertainty into perspective, to guide technological development and innovation and to forecast and plan for the future. It improves job prospects, cultural awareness and our ability to act as well-informed citizens in solidarity with citizens around the world [1].

According to the recent Report of the European Commission (EC) – *Science Education for Responsible Citizenship* [2] in conducting the process of science education it is vital a.o.:

- To promote a culture of scientific thinking and inspire citizens to use evidence-based reasoning for decision making;
- To ensure citizens have the confidence, knowledge and skills to participate actively in an increasingly complex scientific and technological world;
- To develop the competences for problem-solving and innovation, as well as analytical and critical thinking that are necessary to empower citizens to lead personally fulfilling, socially responsible and professionally-engaged lives;

- To inspire children and pupils of all ages and talents to aspire to careers in science and other occupations and professions that underpin our knowledge and innovation-intensive societies and economies, in which they can be creative and accomplished;
- To empower responsible participation in public science conversations, debates and decision-making as active engagement of European citizens in the big challenges facing humanity today.

Above mentioned objectives of science education could be met among others with the use of webinars with scientists, as a method of proposing innovative didactic tool going beyond school routine. Webinars may also help to establish strong links between the research and education communities by connecting schools to scientists working in various places of the world. Webinars conducted by researchers allow to inspire pupils to engage in the learning process and to better understand the role of scientific research in the modern world, scientific messages and scientific language. They help to increase their knowledge about nature, geography, natural resources, history, social science, and political science and to raise awareness about environmental issues and climate change. They may also encourage young people to choose STEM careers, so crucial for the development of knowledge-based societies. One of the project using webinars to strengthen science education curricula across Europe is EDU-ARCTIC.

2 EDU-ARCTIC PROJECT

2.1 General information about the project

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 EDU-ARCTIC project uses 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. The content of each webinar can be adapted according to different school curricula and according to region or country. 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 and educational resources in at least five national European languages. It helps teachers and pupils to prepare for their participation in webinars by providing short explanations of scientific terms used by scientists.

3 Competitions for European pupils and their teachers, in which winners will be invited to take part in the polar expedition and act there as scientists.

4 Environmental monitoring program: All participating schools in Europe will be invited to take part in a 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. The database can be used as a supplement to science classes, most notably in biology, chemistry, physics and mathematics.

5 Teacher workshops and training sessions aiming at giving teachers the right tools to use EDU-ARCTIC resources and become ambassadors of the project in their home countries.

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 (Faroe Islands), Universite de Versailles Saint-Quentin (France), The Arctic Portal (Norðurslóðagáttin ehf) (Iceland). The project is foreseen for 3 years, and started in May 2016, whereas activities for schools started in January 2017. The registration to the program for new schools is still open.

2.2 Why the Arctic and polar research

Polar Regions represent one of the most interesting natural environments that can engage pupils in topics related to global changes [3]. Therefore, some institutions and projects are proposing educational initiatives using polar research as a topic involving youth in STEM education (e.g. APECS Association of Polar early Career Scientists, SCAR Scientific Committee for Antarctic Research or ANDRILL [3], the International Polar Year initiatives [4]). Generally, such initiatives are a part of projects or other activities. Some of them were proposed only on national level (e.g. Italian project bringing inquiry-based polar sciences into Italian classroom [3], or EDUSCIENCE for Polish schools [5]).

EDU-ARCTIC is the first Pan-European initiative dedicated entirely to education, available for secondary schools. The project focuses mainly on natural sciences and research conducted in the European part of the Arctic due to a number of reasons.

2.2.1 Providing at polar stations interdisciplinary research in various scientific disciplines

A vast array of processes and ecosystems can be observed in the Arctic. Representatives of stations from almost all European regions of the Arctic (Svalbard, Iceland, the Faroe Islands and northern Norway) participate in the project. Pupils will thus have the opportunity to see geological, environmental and meteorological differences in order to understand that the Arctic is not homogeneous.

The stations which provide lessons are geographically spread across the Arctic. It is important to be aware of differences between the regions concerned. Even though there are quite similar climate conditions, there are different types of vegetation and considerable biodiversity. Stations in the Arctic are characterized by their high interdisciplinary level. All geophysical surveys are conducted at the stations. Moreover, scientists from all over the world are invited to conduct research in various disciplines, increasing significantly the diversity of potential topics to be addressed by the project. There is an astonishing diversity of research going on in the Arctic. Therefore, by choosing one place, we give pupils access to the wide scale of natural sciences research.

Moreover stations are run by different organisations and nations. The Arctic is culturally and sociologically diversified. Cooperation with stations in various Arctic countries and regions creates the opportunity to present not only natural determinants, but also sociological, demographical and cultural diversity according to the principle that the larger diversity in presented issues is, the bigger the benefit will be for pupils.

2.2.2 Big interest in polar issues in the society

The Arctic is beautiful, unique, specific. By virtue of its simplicity, the Arctic is extremely attractive scientifically and cognitively. All phenomena, described in ecology course books, and which most people do not get the chance to see in a tangible way, take it on word (...). This is happening right before our eyes [6]. The Arctic is an extraordinary space that pupils from most European countries are likely to associate with the idea of a faraway, almost unreachable and mystical place. This makes webinars from the Arctic more interesting than any other webinars conducted in institutions located closer to their home. The difficulty to reach the Arctic makes it even more attractive.

The Institute of Geophysics PAS, Project Coordinator, has a very solid experience in providing Polish schools with the educational program EDUSCIENCE, in which the Polish polar research station also played a major role. Basing on evaluating studies and information gained from surveys and interviews, it was found out that teachers and pupils were frequently indicating that the polar station was one of the most attractive parts of the project. Online lessons conducted at the station and the possibility for pupils and teachers to see everyday life at the station as well as ongoing scientific work, the possibility to ask about weather conditions and research conducted there were very well evaluated [5], [7]. It was also indicated that the project was of unique value as it offered the opportunity to connect with such a faraway place and to receive special lessons, that had not been previously possible in Poland.

3 WEBINARS FOR SCHOOLS

Webinars for schools (online lessons) are the main component of the EDU-ARCTIC program. They are mainly conducted by researchers working at polar stations, which take part in the project (Polish Polar Station Hornsund on Svalbard, NIBIO Svanhovd in Northern Norway, The Faroe Islands Nature

Investigation and Karholl Research Station in Iceland). Additionally, to raise the attractiveness and diversity of scientific subjects, some special transmissions with selected experts in polar research and Earth sciences are provided by other partner institutions and networking organisations.

3.1 Webinars' topics

The range of disciplines and research topics of webinars is really wide and covers environmental sciences, geophysics (seismology, Earth magnetism), geology, geomorphology, climatology, climate change, atmospheric chemistry and physics, hydrology, ecology, soil science, oceanography, microbiology, marine biology, biodiversity, paleoecology, limnology, genetics, zoology, biology. Moreover some webinars will be dedicated to anthropology, the sociology of Arctic regions, human biology and medicine, and to some extent to socio-humanities.

Topics of online lessons are related to polar areas, natural conditions, the history of polar stations, the geopolitical situation of the Arctic, the research carried out in each station. Webinars are conducted with the use of special teleconference tool, which enables participation of over 20 schools in each webinar.

The webinars are conducted in English and on request in national languages (e.g. Polish, Danish, French, German, Norwegian, Faroese, Icelandic). They will also be recorded in order to render them accessible to schools at their own convenience.

Exemplary groups of topics that could be proposed within the program include:

1 Ice & snow (e.g. Glacial processes and landforms, Destructive and elevating activities of glaciers);

2 Climate, weather & atmosphere (e.g. Meteorology beyond the Arctic Circle, Climate change - phenology and carbon cycling, Cyclones in the North Atlantic, The Arctic ozone hole, Atmospheric-stratospheric dynamics over the Arctic, Accumulation of pollutants in the Arctic);

3 Land & geology (e.g. Permafrost, Seismology and Earth magnetism beyond the Arctic Circle, Active erosional landforms, Basaltic landscapes and what they teach us about plate tectonics);

4 Animals & plants (e.g. Spitsbergen's fauna, Polar bear – king of the Arctic, Genetics of the Brown bear population, Hibernating bears and climate change, Land use and grazing by domestic animals, Wildlife monitoring, the big predators in the North/in the Arctic, Adaptation by animals to life in the Arctic, Behaviour of wildlife in the Arctic; migration, annual flyways of birds, reindeer wandering);

5 People & society (e.g. Spitsbergen's means of transport, Greenlandic society and climate change, Reindeer herding and climate change).

3.2 Benefits for pupils of taking part in webinars

It should be stressed that webinars must be interactive. Scientists conducting webinars should involve pupils actively by encouraging them to ask questions and to perform given assignments. It is crucial that pupils become active players in the process of learning. Pupils and teachers have the possibility to take part virtually in experiments and measurements conducted at stations. They are asked to put forth a hypothesis concerning the experiment or phenomena discussed with a scientist. It might help them to develop skills of analytical and logical thinking and the use of research methods to solve problems.

During online lessons pupils may also ask about different phenomena which occur in the Arctic. They become familiar with scientific career opportunities, as well as everyday activities of researchers and their curriculum. It is a new experience for them and an opportunity to detach themselves from school routine. They also gain access to the newest scientific discoveries and reports. Webinars help them to better understand scientific messages, which is a useful skill in everyday life. But they also familiarize themselves with scientific language used in research publications, a crucial skill for their prospective career in science.

There are many positive aspects of webinars, as they:

1 address the challenges faced by young people when pursuing careers in STEM – participation in the project will help pupils to become more familiar with the world of scientific research, especially in the natural sciences and technology;

2 aim at presenting science and technology as an attractive and rewarding path of career, which offers diverse and interesting employment possibilities: thanks to direct contact with scientists and their work, pupils will be able to form their own opinions based on a unique experience which webinars provide;

3 emphasize the value of multidisciplinary and more entrepreneurial research – modern Arctic science is very diverse; research is being conducted in many different fields of the Earth sciences, projects are becoming more and more interdisciplinary. Being able to see what the work of scientist is like, pupils notice how important such qualities are, and how the effects of their work can reply to the demands of the modern world. These aspects will also contribute to a more positive image of science and technology as an attractive path of career.

4 provide innovative, forward-looking science education methods, as well as the possibility to contact scientists directly and participate in the experiments conducted online;

5 enhance the link between creativity and science, as pupils are encouraged to play an active role in online lessons – e.g. answer questions which require creative thinking in search of solutions to scientific problems;

6 make participants (both pupils and teachers) become aware of gender equality issues, by presenting science as an equal opportunity area for both men and women, and weakening the stereotype of a male scientist by introducing female scientists who have chosen careers in the area of natural sciences and technology;

7 provide cross-cutting interaction between schools, polar stations and research institutions from different countries, and also scientists representing different research areas;

8 raise awareness of the importance of trans-disciplinary research – the complexity of connections between different elements of the environment is particularly visible in the Arctic which therefore represents a perfect ground for trans-disciplinary research. Such an attitude towards scientific research is becoming increasingly important and widespread, since different elements of the environment show evidence of growing change – from climate to ocean currents and whole ecosystems.

3.3 Barriers and encountered problems

In Europe thousands of educational projects have been conducted and proposed to schools. Many schools are therefore quite used to participate in educational programs and are becoming very open for new tools and initiatives. However, three main groups of obstacles in effective introducing webinars in European schools have been identified:

1 Technological barriers
   - lack of appropriate multimedia equipment in some schools;
   - possible lack of good Internet connection.

2 Organisational barriers
   - the obligation to implement the curriculum, which may result in reluctance of teachers to conduct classes outside the core curriculum;
   - lack of multi- and interdisciplinary approach, e.g. in countries where science classes are divided into separate subjects (physics, chemistry, biology etc.), a problem of introducing polar research within a particular subject may occur;
   - a small number of hours devoted to the realization of science subjects;
   - focusing on preparation to external exams.

3 The human-factor barriers

   a) related to teachers:
      - fear of using new teaching tools, including ICT tools;
      - reluctance to change the existing, traditional formula of teaching and lack of openness to change teaching approach;
      - issue of intimidating image of the scientist; teachers' fear that they will have not sufficient knowledge or skills, that they will not understand the scientists' language and the fear of ridicule in front of the class.

b) related to pupils:
   - fear of ridicule or stating a wrong hypothesis. Young people, especially in the age of 13-20, are very careful and quite introverted; they may not be willing to ask questions.
   - the passivity of pupils in the learning process;
   - the intimidating image of the scientist, which may cause pupils to be afraid of asking questions;
   - sense of being insignificant in scientific research.

c) related to teachers and pupils:
   - lack of language skills; the seemingly hermetic scientific language may cause misunderstandings

The technological barriers are probably the least significant, as a minimum requirement of multimedia equipment (computer, multimedia projector, web-cameras, speakers and microphone) may be easily met in most European schools. Statistics reveal that computers and projectors are basic equipment in many European schools. Regarding internet requirements they are assumed as low: transfer of 1 Mbs will be sufficient, and the majority of schools in Europe meets these criteria. The consortium conducted a short survey among beneficiaries before the launch of the webinars. According to the survey in 4 out of 5 responding countries (France, Poland, Faroe Islands, Iceland) over 60% of schools are adequately equipped with ICT tools [8].

In the terms of organisational barriers, they cannot be removed within the project, as they concern teaching curricula at national levels. In order to fit the program best to teachers' needs and organisational possibilities, recommendations from teachers are gathered and taken into account while constructing the program.

The EDU-ARCTIC educational program pays special attention to human-driven barriers. To overcome some of the barriers and minimise the probability of their appearance, the following steps are undertaken:

1 Constant technical support helping teachers to use the e-learning portal;

2 Creation and constant enrichment of glossary and dictionaries concerning polar issues available for teachers and pupils;

3 Educator workshops which improve teachers' skills and knowledge in the related topics, enhancing their self-esteem;

4 Special methodological training for scientists on how to provide difficult, scientific information in more accessible and popular ways and to underline fascinating aspects of science;

5 Drawing the attention of scientists to the fact that they should provide lessons and activities in the way which encourages pupils to ask questions and formulate hypothesis, overcoming their shyness. Scientists are also trained to emphasize the importance of the possible future role of todays' pupils in scientific world.

6 Constant help of methodologists – teachers practitioners who are familiar with polar research and Arctic issues, helping scientists with the selection of didactic methods and forms of work with young people.

4 EVALUATION STUDIES

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 and started before schools registered for the program. The first survey concerning the teachers' requirements from the program was conducted during first months of project's implementation. It served as a guideline for webinars. The results of this survey are presented below.

The ongoing evaluation assumes obtaining feedback from teachers participating in webinars after each event. The results are not yet known, but will be crucial for implementation of changes in order to meet teachers' and pupils' needs.

4.1 Requirement analysis survey

Before preparation of EDU-ARCTIC webinar a survey on teachers' requirements was conducted among 42 STEM teachers from secondary schools from 4 countries (Poland, France, Norway and Faroe Islands). The data was collected with the use of a CAWI Survey. CAWI (Computer Assisted Web Interviews) research technique is an interview in which the participant fills 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 [9]. A part of the survey was dedicated to webinars on polar research. Teachers were asked about their experience in participation in webinars, potentially interesting topics and proper frequency of webinars. Language skills of pupils and preferred teaching materials to be used during online lessons were examined [10].

Teachers declared that webinars on polar issues could be performed in regular teaching hours (32 answers), voluntary extra classes (29 answers), compulsory extra classes (10 answers) or extra-curricular classes (3 answers). Half of the schools are ready to use the EDU-ARCTIC program during 5 to 10 hours per school year. Over 20% of responders declared their possibility to use the program during less than 5 hours or during 11 to 20 hours. Only 5% of teachers are ready to conduct the program during more than 20 hours in a school year.

The use of English is seen mainly as a bit of a challenge or even a serious challenge, but the schools are ready to tackle the problem. 24% of the responders considered that English is not a problem for their pupils. Schools from Northern Europe have least trouble with English. For 25% of the French schools and 23% of Polish schools, English is seen as a major problem, but only a very small number of schools declared that they could not use English-language source materials.

Given the relatively sound geographical knowledge of pupils suggested by the survey, attention should be paid on less well-known, but nonetheless important subjects; such as biology, changes and human impact on the Arctic, global impact of Arctic changes. Interestingly enough, these latter subjects were mentioned mostly by responders form the Arctic countries. Scientists should consider this while planning the thematic coverage of their online lessons.

Teachers requested to indicate a few Arctic themes likely to be of interest to their pupils pointed out animals (17 answers), weather, climate and climate change (13 answers), plants (8 answers), northern lights (4 answers) and man in the Arctic (4 answers).

5 DISCUSSION

Some general recommendations on how to conduct inspiring webinars for youth are based on the experience from the EDU-ARCTIC program, as well as three other initiatives (EDUSCIENCE, Scientix and ERIS).

5.1 Various educational initiatives providing webinars for schools

5.1.1 EDUSCIENCE

EDUSCIENCE (full title: Increasing school pupils' competence in the field of mathematics, natural and technical sciences with the application of innovative methods and technologies – EDUSCIENCE) was the biggest innovative project in STEM education for polish schools, co-financed by the European Union within European Social Fund. The key objective of the EDUSCIENCE project was to increase interest in mathematics, natural, computer and technical sciences as well as foreign languages - thanks to fundamental changes in the existing ways of teaching [11]. EDUSCIENCE offered a series of webinars conducted from geophysical observatories, research institutes and Polish Polar Station Hornsund on Svalbard for schools in whole Poland. The educators, scientists mainly from Polish Academy of Sciences, prepared lessons based on their research in the area of Earth sciences and natural sciences. It gave an experience, how to teach online, involving pupils and helping them to understand science and train their skills. The lecture shouldn't be the main way of teaching. It's necessary to involve as many pupils' senses as possible. It's also important to use during webinars the variety of materials (e.g. photos, videos, popular science articles, animations, slideshows, worksheets, quizzes).

Evaluation studies conducted within EDUSCIENCE project showed that techniques and methodology proposed within the project were adequate to improve pupils' interest in learning natural science. They

were assessed by teachers testing them at schools as interesting, involving and more attractive than normal curriculum [5], [7].

5.1.2 Scientix

Scientix is the Community for Science Education in Europe. It is an EU funded project, which promotes and supports a Europe-wide collaboration among STEM teachers, education researchers, policymakers and other STEM education professionals. In its first stage (2009–2012), the project developed an online portal to collect and present European STEM education projects and their results; it also organised several teacher workshops. The goal of the second phase (2013–2016) was to expand at national level. Through the network of the National Contact Points (NCPs), Scientix aimed to reach out to national teacher communities, and to contribute to the development of national strategies for a wider uptake of inquiry-based and other innovative approaches to science and maths education.

Institute of Geophysics, Polish Academy of Sciences acting as Scientix National Contact Point in Poland, conducted more than 10 webinars for polish schools from the Arctowski Antarctic Station. Those online lessons were mainly dedicated to pupils from primary schools. Webinars gained a lot of popularity. Pupils were very active. At some of the webinars more than 100 schools from Poland participated simultaneously.

5.1.3 ERIS – Exploitation of research results in School practice

ERIS is an EU funded project (ERASMUS+) aiming to increase the interest of pupils in lower and upper secondary schools in STEM, and the choice of a scientific career. Thanks to the development, pilot implementation and dissemination of educational packages and methodological materials, research results will be exploited in the education systems of at least 3 European countries: Poland, Romania and France.

30 educational packages (10 per each partner institution) are being developed during the project. They are dedicated to various topics, e.g.: glaciers, earthquakes, geomagnetism, meteorology in the Arctic, UV radiation, ocean waves etc. They use freely available research databases or results published online, which may be analysed by pupils with the help of instructions prepared by scientists. The packages include materials for teachers to work with pupils during classes and/ or extracurricular activities. Webinars dedicated to each topic were complementary to the packages. They were well assessed by teachers participating in them. Teachers assessed the content of the lesson as well tailored to the age of students and presented in a comprehensible manner. They also found the lesson interesting and appreciated that scientists used various materials e.g. presentations, animations, graphics, worksheets. Moreover, most teachers found the lessons useful for implementation of curriculum, which increases the chances of packages to be used by many schools in future.

5.2 Recommendations for conducting webinars for schools

After conducting webinars we found that they gained a lot of popularity and pupils (esp. from primary schools) were very active. Polar regions were extremely interesting for them. But, as some barriers may occur, it is crucial to prepare each webinar taking into account various aspects. Recommendations for conducting webinars may be divided into 3 sections dedicated to various phases: preparation to a webinar, conducting a webinar and some technical aspects [12]. They will be discussed separately.

5.2.1 Preparation to a webinar

Before conducting a webinar organisers should choose the topic and request an expert on this issue to prepare a webinar. Whenever possible, guests – experts on particular topics – may be invited to deliver a lesson in order to make the topic coverage wider. If you want to encourage scientific career among young girls – it is recommended that female scientists as lecturers are represented properly. Each female educator at the beginning of the online lesson may elaborate why and how she decided to follow STEM career.

Invitation for a webinar including information on topic, date and time, school level and pupils' age should be send to teachers minimum 2-3 weeks in advance. It is also recommended to conduct a short introductory webinar only for teachers, when they are able to test the tool and get some information on how to prepare for the online lesson.

If webinars are delivered in language other than national, one need to take into account that the foreign language difficulties are considered by majority of schools as an important challenge. In the description of each lesson, information on required language skills should be provided. Vocabulary useful for the lesson should be known in advance. Each educator should provide key scientific terminology in the description/invitation for the lesson. Moreover, visual materials should be proposed and used to the extent possible.

Given the fact that webinars are likely to be offered during voluntary extra classes, pupils‘ motivation needs to be stimulated by additional activities. It is suggested that short web based competitions for classes could be conducted. Such competitions should be prepared in advance, using applications, which help educators to create and play fun learning games and quizzes for any subject (e.g. Kahoot quizzes).

5.2.2 Conducting a webinar

As webinars should encourage scientific careers and contribute to career advice in schools – it is recommended that each educator at the beginning of the online lesson will elaborate why and how he/she decided to follow STEM career. Personal perspective, information on his/her career path as well as some intriguing science story will be something unique the lesson has to offer. Moreover, if educator starts with a small talk, it helps participating pupils to get familiar with educator’s foreign accent first and enhances the further understanding of the lesson’s content. It is also recommended that online lessons should start with something intriguing, mysterious, unexpected, as this will allow to involve pupils in learning just from the very beginning.

During online lessons pupils' motivation needs to be identified and stimulated by additional activities. Exercises make pupils active; e.g. Kahoot quizzes or worksheets with exercises and tasks to be done by pupils (printed before lesson). Educator may display a worksheet with questions and tasks and a few minutes later display correct answers. Moreover, educators should not provide too much information. They should engage in activities, inspire and surprise pupils, rather than concentrate on facts and information.

The varying degree of willingness among pupils to participate actively in discussions also needs to be taken into account. Younger pupils are generally very keen on communicating actively. They are engaged in sharing their opinions and sending regards via chat. Pupils from secondary schools are more reluctant to active participation, as they might be afraid of ridicule in front of the class. Therefore, various ways of activating pupils are necessary, e.g. some groups willingly engage in questions and answers on chat or take advantage of the possibility to ask questions. Other groups may work independently on their own bases (e.g. using individual worksheets, prepared by educators in advance and sent to teachers before the lesson). Taken this into account, it is advisable to propose various form of collaboration in order to meet needs of different groups of pupils.

5.2.3 Technical aspects

It is recommended that before conducting webinars one choose carefully the tool, which will be used for teleconferences. The tool should enable to provide audio and video streaming and chat function. It should also enable lecturer to share files (e.g. presentations, pdf files, graphics and videos) or display his/her screen. As an example Cisco Webex tool could be suggested.

Taking into account the lack of experience of the majority of schools as far as their participation in online lessons is concerned, special attention should be paid to this problem. Having some testing webinars targeting exclusively teachers could be a good opportunity. Technical assistance should be provided by additional person during the webinar. Such a person may send suggestions via chat on how to solve technical problems (e.g. with video and audio connection).

If the webinar is organised from a place, when Internet connection may be affected (e.g. by weather conditions, as it might take place at the polar stations), it is advisable to have the other expert in different location ready to overtake the presentation.

6 CONCLUSIONS

Webinars may be a useful and effective method of increasing interest of youth in science and scientific careers. There is an evidence from a few educational initiatives, mentioned in the paper, that webinars are found by teachers and pupils as an attractive and inspiring method of going beyond school routine. However, as some barriers may occur, while introducing webinars, they require special

preparations in terms of content, proposed didactic methods and overcoming some technical or linguistic problems.

The interest of schools and policymakers in the field of education and polar research is really big. As EDU-ARCTIC activities are conducted mainly online, there are no limitations in the number of schools participating in the program. Therefore, all interested schools may register on the portal: http://edu-arctic.eu/program/teachers/register.

Moreover, scientific institutions conducting polar research are welcome to cooperate with the Consortium to disseminate their research results via EDU-ARCTIC webinars. For contact details please visit http://edu-arctic.eu/about/contacts.

ACKNOWLEDGEMENTS

EDU-ARCTIC project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 710240. The content of the document is the sole responsibility of the author 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] European Commission, "Responsible Research and Innovation (RRI), Science and Technology", 2013. (http://ec.europa.eu/public_opinion/archives/ebs/ebs_401_en.pdf, 5.01.2017).

[2] European Commission, "SCIENCE EDUCATION for Responsible Citizenship", 2015. (http://ec.europa.eu/research/swafs/pdf/pub_science_education/KI-NA-26-893-EN-N.pdf, 15.01.2017.)

[3] M. Macario, C. Invernizzi, E. Paris, F. Talarico, "Case study, resources, ideas and practice to bring inquiry-based polar sciences into Italian classrooms" in: A. Raschi et al: Science education and guidance in schools: the way forward. Printed in Italy: 201-207, 2013

[4] B. Kaiser, B. Allen, S. Zicus, "Polar Science and Global Climate, An International Resource for Education and Outreach", Pearson, 2010.

[5] P. Stankiewicz et al., "Moving schools closer to the world of science: Innovative solutions for education in EDUSCIENCE project", 120 p., 2015.

[6] D. Adamkiewicz, J. Łęska. "Little auk, big deal", talk by L. Stempniewicz (video), 2013.

[7] "Evaluation report for EDUSCIENCE project – report ex-post", (in polish), 2014. (http://eduscience.pl/bundles/edusciencemain/files/pages/Zal._14._EDUSCIENCE_RAPORT_EX-POST_ (2014).pdf).

[8] K. Man, "Report on desk research", 2016. (http://edu-arctic.eu/library/project-reports/36-d3-1-report-on-desk-research).

[9] H. Sharp, Y. Rogers, J. Preece, "Interaction Design: Beyond Human-Computer Interaction", John Wiley & Sons, Inc. 2002.

[10] J. Borm, J. Kodzik, "Report on requirement analysis", internal report of EDU-ARCTIC project, 2016.

[11] A. Goździk "EDUSCIENCE project – effective way of teaching natural sciences at polish schools" *In: A. Raschi et al: Science education and guidance in schools: the way forward.* Printed in Italy: 155-158, 2013.

[12] K. Man, "Recommendation for EDU-ARCTIC program", 2016. (http://edu-arctic.eu/library/project-reports/37-d3-3-recommendation-for-edu-arctic-programme).