Integrated Arctic Observation System

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Deliverable 7.9

Educational materials for teachers and students of lower and upper secondary schools to enhance literacy of Arctic Observations among teachers and students

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Author of the report: Agata Goździk (IG PAN). Authors and contributors to the videos: Thomas Juul-Pedersen (GINR), Anna Myśliwiec (IG PAN), Darko Matešić (IG PAN), Sebastian Szczurtek (IG PAN), Anna Wielgopolan, (IG PAN), Hanne Sagen (NERSC), Ariel & Neil Weisbrod (contractors), Andreas Ahlstrøm (GEUS), Håvard Sagen (NTNU), Bjørnar Hallaråker Røsvik (NERSC), Kjetil Lygre (NERSC)

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13	SMHI		**36**	RIHMI-WDC	
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20	UPM		**43**	NMEFC	
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PU	Public, fully open	X
CO	Confidential, restricted under conditions set out in Model Grant Agreement	
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EXECUTIVE SUMMARY

This report provides an overview of educational materials, which were produced specifically by INTAROS for teachers and students of lower and upper secondary schools in order to enhance literacy of Arctic Observations among teachers and students. In the D7.7 report on existing teaching and outreach material the INTAROS Consortium provided an overview of the various products targeting for teaching and outreach purposes. Although, there are many polar materials available, they were not specifically targeting schools in the context of monitoring and field works. This material includes real life examples of field campaigns and observations conducted in the Arctic, which goes beyond the more general picture of scientific work presented in the previously available resources. It is also oriented towards demonstration of various monitoring tasks in order to inspire interest of youngsters in undertaking similar careers in the future. Moreover, the presented packages have a different form of structured online activity created on the platform dedicated to usage by STEM teachers.

The educational material is foreseen as a tool for promoting natural science to students and early recruitment of future potential polar researchers. The educational materials consist of two packages dedicated to terrestrial and marine observations in the Arctic. Packages are created on an open-source online platform, which enable using them in classrooms as well as individually by students at home. Each package consists of materials for students organised in a structured way in the GO-LAB platform and guidelines for teachers included in this report.

The materials for students consist of texts, graphics, videos and online games and quizzes. They include products produced within the INTAROS project as well as material from other Arctic projects connected to INTAROS. Furthermore, the material includes the INTAROS marine TABOO game, all apps inside the Graasp spaces) as well as products produced outside the project that are considered particularly relevant, informative and useful for achieving educational goals set in each package (e.g. National Geographic videos, Beautiful Destinations video, WMO video, TedEd lesson by William Chapman, Polarpedia resources from the EDU-ARCTIC Horizon 2020 project). Video material created by INTAROS partners (IG PAN, NERSC, GEUS, and GINR) and dedicated to this purpose is considered especially useful for career path counselling purposes.

The first package is dedicated to the terrestrial monitoring of the Arctic. Students get the general information about the Arctic, its borders and living conditions and find out why integrated Arctic observation system is crucial for understanding our Planet. Moreover, they learn what is observed and what are the main ways of collecting of data. They also become familiar with researcher's work at polar stations.

The second package is dedicated to the Arctic Ocean and its monitoring. Through the videos provided by INTAROS and related projects students learn about the importance and uniqueness of the Arctic Ocean, how the sea ice extent is changing over years and what are the consequences of the melting ice and why the Arctic Ocean observations are crucial for understanding the planet. Moreover, they can become familiar with researcher's work in polar regions and learn about various parameters measured and observed within marine monitoring.

In the final section of the report a summary of dissemination and training activities foreseen for educational packages are briefly described.

Table of Contents

1. Introduction

The INTAROS Consortium provided an overview of the various educational material and tools in the D7.7 report from November 2019. Although, there is plenty of educational material available on polar topics, they are not specifically targeting schools in the context of monitoring and field work. This material includes real life examples of field campaigns and observations conducted in the Arctic, which goes beyond the more general picture of scientific work presented in the previously available resources. It is also oriented towards demonstration of various monitoring tasks in order to inspire interest of youngsters in undertaking similar careers in the future. Moreover, the presented packages have a different form of structured online activity created on the platform dedicated to usage by STEM teachers (STEM: Science, Technology, Engineering and Mathematics).

The educational material is foreseen as a tool for promoting natural science to students and early recruitment of future potential polar researchers.

The report presents two packages of educational materials for teachers and students of lower and upper secondary schools, one with focus on terrestrial activities and one with focus on marine and sea ice activities. The material aims to enhance literacy of Arctic Observations among teachers and students. Each package consists of methodological material for teachers, and students, including text, graphics, videos and online games and quizzes. The material is produced within the INTAROS project as well as in other related projects. Other material considered to be particularly relevant is also listed (e.g. National Geographic videos, Beautiful Destinations video, WMO video, TedEd lesson by William Chapman, Polarpedia resources from the EDU-ARCTIC Horizon 2020 project). Much of the video material created by INTAROS is made for general dissemination and outreach, it can be useful for teacher and students from junior high school level and upwards.

The online version on the Graasp platform is used to prepare the packages. Graasp is an independent authoring and learning platform integrated with Go-Lab ecosystem, see https://graasp.eu/ and https://www.golabz.eu/. Go-Lab is the ecosystem for inquiry learning with online laboratories for STEM (Science, Technology, Engineering, and Math) domains. The Go-Lab ecosystem is supported by the Go-Lab community with more than 5000 teachers worldwide.

Each package is foreseen for 2-3 dedictical hours. However, teachers may also hide some sections in Graasp, if they cannot dedicate so much time for implementation of the package. Moreover, even single tasks or materials in sections could be hidden by teachers or skipped by students. It gives freedom in implementation of the foreseen tasks and is important, if the time for the implementation of the package is limited.

2. Educational package for terrestrial monitoring

Brief Description: The package is dedicated to the monitoring of the Arctic. Students get the general information about the Arctic, its borders and living conditions and find out why integrated Arctic observation system is crucial for understanding our Planet. Moreover, they learn what is observed and what are the main ways of collecting of data. They also become familiar with researcher's work at polar stations and learn about work of meteorologist, geomagnetic observer, hydrochemist, glaciologist, geologist and geomorphologist. Thanks to that they may draw conclusions about working in the field and assess how they would like it.

Keywords: Arctic, Svalbard, terrestrial monitoring, meteorology, Earth magnetic field, hydrochemistry

Age Range: 14-18

Didactical Hours: 2-3 didactical hours

Learning objectives: The student will:

- learn about the Arctic climate and environment, its borders and living conditions;
- learn, why integrated Arctic observation system is crucial for understanding our Planet, what is observed and what are the main ways of collecting of data;
- become familiar with researcher's work at polar stations;
- learn about work of meteorologist, geomagnetic observer, hydrochemist, glaciologist, geologist and geomorphologists;
- learn about working in the field and assess how she or he would like to be involved in such work.

The package is available on the Graasp platform: https://graasp.eu/s/zg2db8

The package consists of 6 sections, described below.

2.1 Welcome to the Arctic

Description of the section:

In this section the general information about the Arctic is provided. Students learn that the Arctic is the northernmost region of the Earth, surrounding the North Pole. Its surface area is around 45 million square kilometers, 1/3 of which consists of the Arctic Ocean and surrounding seas. In this area only ca. 4 million people live, which makes the Arctic one of the most sparsely populated areas of Earth. Circa 10% of this number are indigenous peoples – nations, who have lived in the Arctic since long before Europeans arrived in the region.

Then, students are informed that several international organizations and committees have different definitions which include various regions of the northern areas of our planet into the Arctic depending on various cultural and/or environmental criteria. They see various borders on the map.

The last part of this section is watching the video about huge untouched landscapes, rough weather that constantly changes, rich wildlife and people who live through this daily.

Links to videos and other material

- Graasp package – section 1 "Welcome to the Arctic" https://cloud.graasp.eu/en/pages/5f6c5d9b1c204b05b6027cb1/subpages/5f6c5fc01c204b05b6027ccd
- Explanation on the Arctic in Polarpedia: https://polarpedia.eu/en/arctic/ (external resource. Project leader: Agata Goździk)
- Life in the Arctic Circle – Northern Norway – video: https://youtu.be/kl28cbwSq5U (external resource. Janssens, A., Fatton, F., Ouillet, L.)

Estimated time needed: 15 minutes

2.2 Arctic observations

Description of the section:

This section aims at explaining why integrated Arctic observation system is crucial for understanding our Planet, what is observed and what are the main ways of collecting of data. The INTAROS project develops an integrated Arctic Observation System by extending, improving and unifying existing systems in the different regions of the Arctic. INTAROS have a strong multidisciplinary focus, with tools for integration of data from atmosphere, ocean, cryosphere and terrestrial sciences, provided by institutions in Europe, North America and Asia. This novelty is demonstrated in this section.

First, students watch the video about the Integrated Arctic Observation System developed within the INTAROS project. Next, students should imagine that they are experts, who were invited to a TV show to explain, why is Arctic observation system so important for understanding of the Planet. Students are asked to prepare a concept map, which will help them remember all important concepts related to this issue. Students may use the terms provided or add their own ones. For this task students may use the *Concept Mapper* tool, which let learners create concept maps, to get an overview of the key concepts and their relations in a scientific domain. They can define their own concepts and relations or choose from a list of predefined terms. Teachers may change the configuration of this tool. They can add, remove or adjust the predefined terms to fit their domain and adapt the content of the help file. It is also possible to offer a partly finished concept map for learners to extend or correct.

Links to videos and other material

- Graasp package – section 2 "Arctic observations" https://cloud.graasp.eu/en/pages/5f6c5d9b1c204b05b6027cb1/subpages/5f859e51177ca746ffdf5bb6

- INTAROS: Integrated Arctic Observation System – a EU Horizon2020 project 2016-2021, (6 min) https://www.youtube.com/watch?v=4zphDKqTRNs&feature=youtu.be (Producer: Ariel Weisbrod and Neil Weisbrod. Target Group: Students at high school and universities.

- INTAROS: Field work on the Greenland ice sheet. Video provided by Andreas Ahlstrøm, GEUS: (5 min.): https://www.youtube.com/watch?v=H4K8rspioOM

2.3. Working at an Arctic research station

Description of the section:

In this section students find the Polish Polar Station Hornsund on Svalbard on the map. Next, they watch three videos taken at the station and become familiar with researchers' work at polar stations.

The Polish Polar Station in Hornsund is located in Isbjornhamna Bay of the Hornsund Fjord. It represents the southern part of the Norwegian Island of Spitsbergen, part of the Svalbard Archipelago. This establishment conducts year-round scientific research. Students may learn more about research conducted there on the website presented as additional source.

Students start with the video about meteorological tasks. They learn what a meteorologist does in the Arctic and what kind of measurements and observations are conducted in the Polish Polar Station Hornsund on Svalbard. After watching the video they are asked to fill in the input box with information on the main meteorological parameters measured or observed in Hornsund.

Next video is dedicated to geomagnetic observations at the Polish Polar Station Hornsund on Svalbard. Students find out what is measured and what is the aim of these observations. Aviation, GPS and satellite telecommunication providers use geomagnetic data. It serves also researchers to investigate internal structure of the Earth. Then, they answer two questions in the quiz.

The last video in this section is dedicated to hydro-chemical measurements. After watching the video students are asked to name 3 steps of work with the samples of water. In winter snow is collected, whereas in summer rain and water samples from streams. Are there any differences in dealing with these various samples?

Links to videos and other material

- Website for the Polish Polar Station: https://hornsund.igf.edu.pl/about-the-station/scope-of-research/ (Provided by Institute of Geophysics, Polish Academy of Sciences)
- Meteorologist on Svalbard. Video 2 min.) provided by Sebastian Szczurtek (IG PAN): https://youtu.be/hn0J1jDg2JY
- Geomagnetic observations at the Polish Polar Station Hornsund. Video (1.5 min.) provided by Anna Myśliwiec (IG PAN): https://youtu.be/7J_E2qjmCYA
- Hydrochemist's work at the Polish Polar Station Hornsund. Video (2.0 min) by Darko Matešić (IG PAN): https://youtu.be/Oc0uGGhJ90U
- Graasp package – section 3 "Working in the Arctic" https://cloud.graasp.eu/en/pages/5f4cc907731a3042d5e92df6/subpages/5f4cc908731a3042d5e92dfc

Estimated time needed: 20 minutes

2.4. Arctic career opportunities

Description of the section:

In the previous section students learned about work of meteorologist, geomagnetic observer and hydrochemist. In this section they learn about a few other career opportunities in the Arctic: glaciologist, glaciospeleologist, geologist and geomorphologists.

For this purpose, terms from Polarpedia are used. Polarpedia is a free online encyclopedia on polar research. It is a tool of EDU-ARCTIC's educational program, accessible without registration, and an extensive knowledge base of the Arctic, with more than 500 terms translated to 16 national European languages.

Links to videos and other material

- https://polarpedia.eu/en/glaciologist/ (Project leader: Agata Goździk)
- https://polarpedia.eu/en/glaciospeleologist/ (Project leader: Agata Goździk)
- https://polarpedia.eu/en/geologist-and-geomorphologist/ (Project leader: Agata Goździk)
- Graasp package – section 4 "Arctic career opportunities" https://cloud.graasp.eu/en/pages/5f6c5d9b1c204b05b6027cb1/subpages/5f8591f9df329d51f1fd49b5

Estimated time needed: 15 minutes

2.5. Want to be a polar researcher?

Description of the section:

In this section students have a chance to think of advantages and challenges of the work in polar regions. Students are asked to think what are the advantages and drawbacks or challenges of working in polar regions. They create a concept map (using the *Concept Mapper* tool described above). In the concept map they may use provided concepts and add as many own ideas as come to their mind. Then, they decide if the concepts are positive for them (something that would encourage them to take such job), negative (something discouraging) or neutral. For some concepts they may decide that they might be both positive and negative (e.g. wild animals - it may be fascinating to observe wild species in the natural environment, but it is also dangerous to meet a polar bear). In such case they may add such concept twice and add explanations.

After each student prepared his/her concept map, they may want to discuss their findings with their peers. Teacher may divide the class into groups, where students may share ideas and opinions and try to summarize various answers. For this purpose the *Collaboration tool* was added to this section. Groups of students can share their concept maps. In the Collaboration tool within Graasp, teacher can distribute students into collaboration groups. This can be done before students login to the section, in which case they need to use the login names the teacher has given them, or after the students have logged in, in which case the names the students have chosen to log in are available for the teacher. The student's view of this tool displays to the student the names of all the members within the same collaboration group.

The final task, once students discussed the opinions on working conditions in the Arctic with their peers, they are asked to write a short text explaining their point of view. Would they like to work as a researcher in the Arctic? Why? Why not?

Links to videos and other material

- Graasp package – section 5 "Want to be a polar researcher?" https://cloud.graasp.eu/en/pages/5f6c5d9b1c204b05b6027cb1/subpages/5f859206df329d51f1fd49b9

Estimated time needed: 25 minutes

2.6. Wrap-up session

Description of the section:

In this section students have a chance to test themselves and to express their feelings about the activity. In the previous sections they learn about various careers, which may be done at a polar station. Students are asked to match the names of occupation with activities typical for each

job. For this they use *Name The Frame* tool. Students drag–and-drop these names into the correct frames in the image. To check their answers, they click on the check mark on the left.

The final task is evaluation of the activity. Students are asked to answer a few questions, how they find this activity.

Links to videos and other material

- Graasp package – section 6 "Wrap-up session" https://viewer.graasp.eu/en/pages/5f6c5d9b1c204b05b6027cb1/subpages/5f92fcff67bfc43f9e79c14e

Estimated time needed: 5-10 minutes

3. Educational package for marine monitoring

Brief Description: The warming trend in the Arctic is twice as large as the global average in recent decades. The loss of sea ice amplifies the warming trend because the ocean surface absorbs more sun heat than the surface of snow and ice. How does that affect the planet? This INTAROS educational package will teach the students about the importance and uniqueness of the Arctic Ocean, how the sea ice extent is changing over years and what are the consequences of the melting ice and why the Arctic Ocean observations are crucial for understanding the planet. Moreover, they will become familiar with researcher's work in polar regions and learn about various parameters measured and observed within marine monitoring. They will be able to learn about working in the field and assess how they would like it.

Keywords: Arctic Ocean, Greenland, marine monitoring, sea ice, salinity, nutrients

Age Range: 14-18

Didactical Hours: 2-3 didactical hours

Learning objectives: The student will:

- learn about the Arctic Ocean, its area and main features;
- learn how the sea ice extent is changing over years and what are the consequences of the melting ice;
- why the Arctic Ocean observations are crucial for understanding the planet;
- become familiar with researcher's work at polar stations;
- learn about various parameters measured and observed within marine monitoring and why they are important;

- learn about working in the field and assess how she or he would like to be involved in such work.

The package is available on the GO-LAB platform: https://graasp.eu/s/t4f5cb

The package consists of 6 sections, described below.

3.1. Welcome to the Arctic Ocean

Description of the section:

In this section the general information about the Arctic Ocean is provided.

First, students are asked to match areas of oceans to their names. For this purpose, *Name the Frame* tool was used. The World Ocean comprises five oceans. Once students drag and drop the areas of the oceans correctly, they may read more about all five oceans by clicking on "i" icon.

Next, students learn that the Arctic Ocean is the smallest and shallowest of the world's five major oceans covering ca. 14 million square km. It is also known as the coldest of all the oceans. The International Hydrographic Organization (IHO) recognizes it as an ocean, although some oceanographers call it the Arctic Mediterranean Sea. They also view the map of the Arctic region showing the Northeast Passage, the Northern Sea Route and Northwest Passage, and bathymetry.

Then, students watch the video about the Arctic Ocean (4:28) and are asked to remember, why the Arctic Ocean is such an important ecosystem. The Arctic Ocean's surface temperature and salinity vary seasonally as the ice cover melts and freezes; its salinity is the lowest on average of the five major oceans, due to low evaporation, heavy fresh water inflow from rivers and streams, and limited connection and outflow to surrounding oceanic waters with higher salinities. The summer shrinking of the ice has been quoted at 50%. The US National Snow and Ice Data Center (NSIDC) uses satellite data to provide a daily record of Arctic sea ice cover and the rate of melting compared to an average period and specific past years, showing a continuous decline in sea ice extent. In September 2012, the Arctic ice extent reached a new record minimum. Compared to the average extent (1979-2000), the sea ice had diminished by 49%.

Finally, they watch Arctic Sea Ice animation (0:54) and find out more about disappearing sea ice.

Links to videos and other material

- "Arctic. Exploring Oceans". Video (2.5 min.) by National Geographic: https://youtu.be/umAeFKF2uxA
- "Arctic Sea Ice 1984 2018: Video by World Meteorological Organization (1 min.) based on data from National Snow and Ice Data Center.https://youtu.be/dIQi64EudeA

- Graasp package – section 1 "Welcome to the Arctic Ocean" https://cloud.graasp.eu/en/pages/5f85a570177ca746ffdf5c8a/subpages/5f85ab12177ca746ffdf5ce4

Estimated time needed: 25 minutes

3.2. Why sea ice is so important

Description of the section:

In this section students find out why the Arctic Ocean observations are crucial for understanding the planet. They start by watching a TedEd lesson by William Chapman *"Why the Arctic is climate change's canary in the coal mine"* (3:58). The climate of the Arctic can be both an early indicator of the climate of the rest of the Earth and a driver for weather patterns across the globe. William Chapman explains why scientists often describe the Arctic as the "canary in the coal mine" when it comes to climate change. It might be necessary to watch the video twice.

In the previous section they learnt how the sea ice extent is changing over years. Watching the video they learn about the various consequences of the melting ice - positive and negative feedback loops. Melting sea ice increases the moisture and helps formulating clouds. This is an example of negative feedback loop. However, the system is not in equilibrium. Teachers ask students why the system is not stable. They write their explanations in the *Input box* or in their notebooks.

Links to videos and other material

- Lesson by William Chapman "Why the Arctic is climate change's canary in the coal mine" (4 min video): https://youtu.be/lrEM3LHvjI0

- Graasp package – section 2 "Why sea ice is so important" https://cloud.graasp.eu/en/pages/5f85a570177ca746ffdf5c8a/subpages/5f858c5fdf329d51f1fd4924

Estimated time needed: 15 minutes

3.3. Marine monitoring

Observing the ocean in ice covered regions.

In this section the students will address the ocean under the sea ice. The ocean under the Arctic sea ice is one of the least observed components of the Earth System. This is because it is expensive, and logistically and technically to carry out field experiments and to provide year-round autonomous observing systems in these regions. In open ocean one can use Argo floats, and gliders in addition to bottom anchored moorings. To observe the ocean under the ice this is

much more difficult as the ice prohibits the floats and gliders to surface. In ice covered regions the usual solutions are to use fixed moorings and ice buoys drifting with the ice. If one wants to use Argo floats or gliders acoustic networks for geo-positioning are needed.

In the following films about field experiments in the Fram Strait, North of Svalbard and the Nansen Basin the students can learn about operations in ice covered regions, deployment/recovery of moorings, and how to use acoustic thermometry. To learn about the new EOV 'ocean sound' we recommend using the https://dosits.org. These resources have used as part of the researcher schools for the Norwegian Funded project Useful Arctic Knowledge. Educational material from these schools will be prepared for use.

In this section students learn about the oceanographic measurements and observations conducted in the Arctic. First, they study the infographic about field activities conducted within the INTAROS project. Oceanographical measurements and observations are described in blue boxes. Next, students watch a teaser (3:10) about the 17 scientists heading north of Svalbard with the Norwegian icebreaker KV Svalbard in September 2018. Their goal was to deploy moorings heavily equipped with instruments to measure ocean temperature, salinity, and chemical properties for 1-2 years. These measurements are important for monitoring changes in the Atlantic water flowing into the Arctic Ocean. During the cruise the scientists were carrying out light and turbulence measurements in the ocean under the ice, in open ocean, and near ice shelves. Changes in the ocean properties and processes will influence the ecosystems in this region. In this way the INTAROS project contributes with important observations from the sparsely sampled ocean North of Svalbard.

Teacher may then start a discussion with students, if they would like to take part in such an expedition. Why? Why not? Students should be precise in giving and supporting their reasoning. After discussion, each student may fill in the *Input box* and explain own reasons.

Links to videos and other material

- Graasp package – section 3 "Marine monitoring" https://cloud.graasp.eu/en/pages/5f85a570177ca746ffdf5c8a/subpages/5f6c5daa1c204b05b6027cb7

- INTAROS 2018 trailer (3 min): https://youtu.be/JHiZB4XbD08 (Håvard Sagen, Art Student at Norwegian Technical University, NTNU)

- INTAROS. Scientific Cruise 2018 North of Svalbard. (16 Minutes) https://www.youtube.com/watch?v=WWC_XfO7Lc8. (INTAROS resource. Project Coordinator: Stein Sandven; Cruise leader Hanne Sagen). Producer: Håvard Sagen (Art Student at Norwegian Technical University). Target Group: Students at high school and university.

- Float Your Boat. https://www.youtube.com/watch?v=zmRgv4cYmSg&t=3s. This is a video of when scientists from the Nansen Environmental and Remote Sensing Center deployed 400 small boats on a ice floe of Svalbard with help from the ice breaker KV

Svalbard. The Boats were prepared by children from Gjesdal, Norway and Seattle, USA. This was done for the Float Your Boat project during the CAATEX 2020 research cruise North of Svalbard. This is a contribution from CAATEX project (project leader: Hanne Sagen), the Float Your Boat Project (Kjetil Lygre) and the INTAROS project (UiB, NORCE). Producer: Bjørnar Hallaråker Røsvik (NERSC, and student at University of Bergen). Target group: School Children.

- UNDER-ICE: Arctic Field Experiment with KV Svalbard 2014 and 2013. These are videos about operations in ice deploying moorings for ocean observations including acoustic thermometry in the Fram Strait. It also explains the use of acoustic thermometry and passive acoustics: https://www.youtube.com/watch?v=FwmfQmejOPI&t=156s (24 min) and https://www.nersc.no/video/scientific-cruise-kv-svalbard-84-north (17 min.) These films are contribution from UNDER-ICE (project leader: Hanne Sagen). Producer: Neil and Ariel Weisbrod. Target Group: Students at high school and university.

Estimated time needed: 20 minutes each.

3.4. Working in the field

Description of the section:

In this section students learn how marine monitoring is conducted in Greenland. First, students watch a short animation (1:44) about Greenland. Next, Thomas Juul Pedersen, senior scientist from the Greenland Climate Research Centre and the Greenland Institute of Natural Resources takes students on a journey by boat and describes the measurements and observations, which are conducted (3:00).

Students are requested to remember important parameters measured by researchers. After watching the video they solve a short quiz. Once they read the questions, it might be necessary to watch the video again.

Links to videos and other material

- Quick facts about Greenland. A 2 min. animation created by Anna Wielgopolan, IG PAN): https://youtu.be/9UBfPwpIqsI
- Marine monitoring in Greenland. Video (3 min.) by Thomas Juul Pedersen, GRIN: https://youtu.be/Q_JALhAO96U
- Graasp package – section 4 "Working in the field" https://cloud.graasp.eu/en/pages/5f85a570177ca746ffdf5c8a/subpages/5f85ab6a177ca746ffdf5ced

Estimated time needed: 10-12 minutes

4.5. Let's play

Description of the section:

In this section students play a game similar to TABOO. TABOO rules: One person draws a card with a word and describes it so that the other players can guess it. Players cannot use any part of the word to be guessed nor synonyms. They cannot use four prohibited words that are on the card under the main word. The **INTAROS marine TABOO** contains 18 arctic words or phrases to be guessed. Teachers may print the pages and cut them into 18 pieces. Then, distribute the cards to playing teams.

If you cannot play TABOO in the classroom, you may do another exercise using the cards above. Let your students draw three cards and give explanations to given words (1-2 sentences per each password) not using the forbidden words. Students write the explanations in the *Input box* in GO-LAB or in their notebooks.

Another way of using the cards is to do it as homework or extra activity. Students are drawing a few (2-3) cards and recording their explanations (e.g. with the use of mobile phone). Each explanation shouldn't be longer than 20 seconds. Then, they upload the video below. In the classroom you may then broadcast the videos and guess the words.

Remember, that students should not read all cards. They should see and use only those, chosen by the teacher or drawn.

Links to videos and other material

- Graasp package – section 5 "Let's play" https://cloud.graasp.eu/en/pages/5f85a570177ca746ffdf5c8a/subpages/5f85ab7c177ca746ffdf5cf0

Estimated time needed: 15 minutes

3.6. Wrap-up session

Description of the section:

In this section students are asked to summarize what they learned and express their feelings about the activity.

Ask students to imagine that they are scientists, who conduct marine monitoring in the Arctic. They need to get funds for their research project. Students should prepare a concept map with list of observations they would like to conduct and why are they important. This map may be prepared in the *Concept Mapper Tool* or using other tools or paper and pencil. The map may help them to prepare for a discussion with head of the institute to convince him or her to finance their research programme. Students may use the concepts and links given and add their own

explanations or add their own concepts. They do not need to use all parameters (3-4 would be enough). Teacher should remind students that good explanations are crucial in this task.

The final task is evaluation of the activity. Students are asked to answer a few questions, how they find the activity.

Links to videos and other material

- Graasp package – section 6 "Wrap-up session" https://cloud.graasp.eu/en/pages/5f85a570177ca746ffdf5c8a/subpages/5f85a6f7177ca746ffdf5c9c

Estimated time needed: 10-15 minutes

4. Next steps

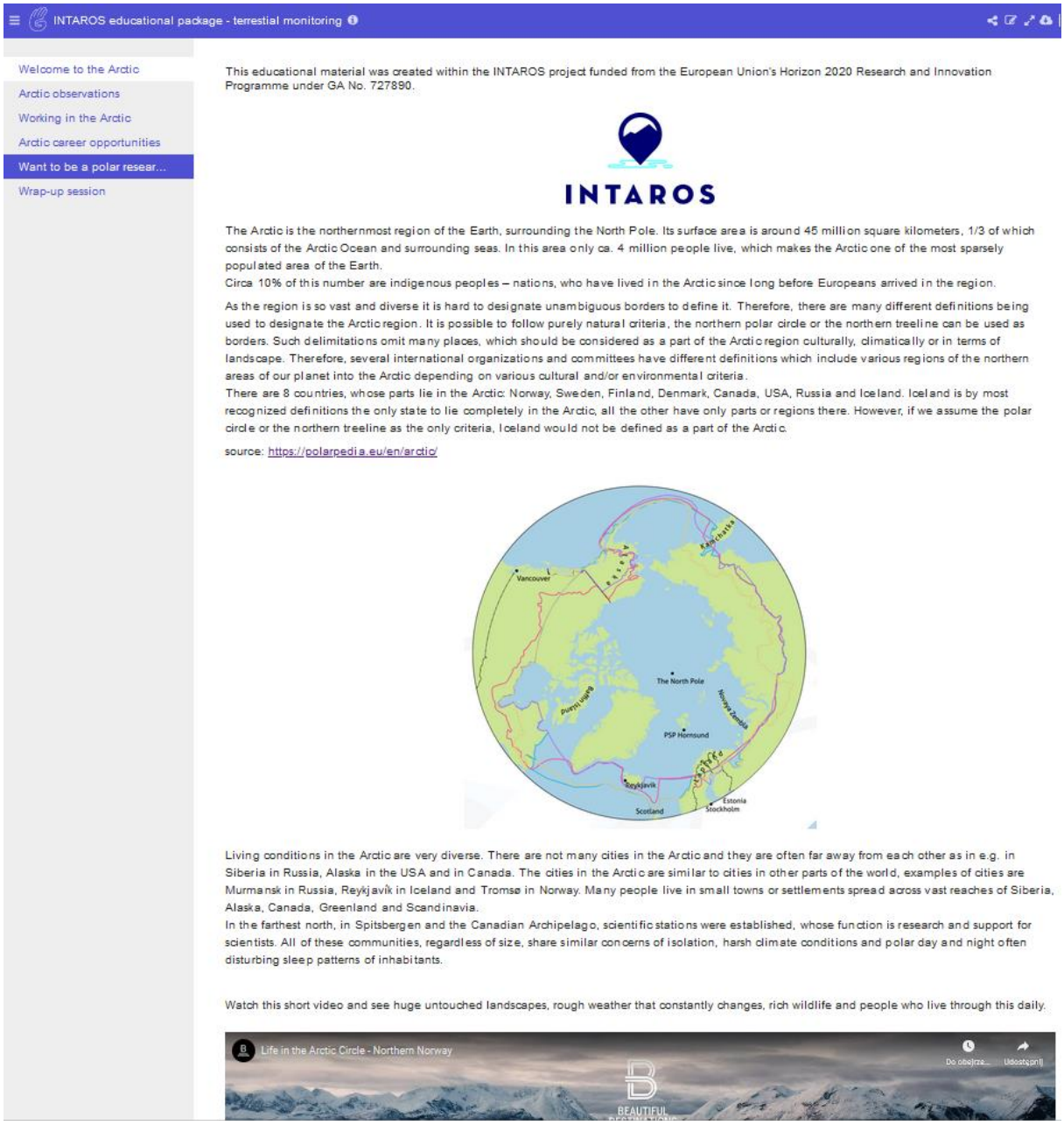
The INTAROS Consortium plans various activities in order to disseminate the educational packages among teachers and educators and to facilitate the use of packages in the school practice. The packages are freely available on the graasp.eu platform. They will be also promoted via Scientix repository (http://www.scientix.eu/resources). Scientix is community for science education in Europe and promotes and supports a Europe-wide collaboration among STEM (science, technology, engineering and maths) teachers, education researchers, policymakers and other STEM education professionals. The first step will be to add the INTAROS project to the Scientix projects' repository. Once accepted, both packages will be added to the resources' repository. This way they will be promoted in the Scientix website and Scientix Digest (received by more than 2300 teachers and educators from European countries and beyond).

Moreover, schools will be encouraged to use packages via different activities e.g. sending invitation to STEM teachers collaborating with the Institute of Geophysics Polish Academy of Sciences, and contacting teachers from at least five European countries taking part in the EDU-ARCTIC project.

An effective way of bringing the packages into schools is to train teachers on how to use them. Teachers will be prepared for using packages during online and/or face-to-face workshops (depending on the pandemic situation) conducted within cooperation with other European projects e.g. Scientix 4 (Horizon 2020, GA no. 101000063), EDU-ARCTIC2 (EEA grant), or POLAR STAR (ERASMUS+ GA no. 2019-1-FI01-KA201-060780).

Appendix 1. Screen shots from the packages

Package 1 - Terrestial monitoring




INTAROS educational package - terrestial monitoring
Welcome to the Arctic
Arctic observations
Working in the Arctic
Arctic career opportunities
Want to be a polar resear...
Wrap-up session
The environment in Arctic region is now changing significantly due to increased temperature, thinning and decrease of the sea ice, melting of the Greenland Ice Sheet, thawing permafrost and changes in atmosphere and ocean circulation. Such changes have global as well as regional implications, including e.g. natural hazards, extreme weather, sea level change, coastal erosion and changes in the ecosystem. These changes have severe impact on people's living conditions in the Arctic. Furthermore, exploitation of resources, marine transportation and other human activities are expected to increase with additional impact on the vulnerable environment. In order to ensure sustainable development of the Arctic it is necessary to collect more data and build up more knowledge on climate and environment in this region. At the start of the project INTAROS brings together expertise from 49 partner organizations in 20 different countries in Europe, North America and Asia with the long-term goal to implement an integrated sustainable Arctic Observation System for future generations.
INTAROS: Integrated Arctic Observation System - a EU Horizon2020 project (2016-2021)
Kopiuj link
Imagine that you are an expert, who was invited to a TV show to explain, why is Arctic observation system so important for understanding of the Planet. Prepare a concept map, which will help you remember all important concepts related to this issue. You may use the terms provided or add your own ones.
Concept Mapper
In situ observations
atmosphere
ways of data collection
parts of geosystem included
integrated system
ways of data collection
satellite Earth observations
parts of geosystem included
parties engaged
ocean
parts of geosystem
parties engaged
20 countries
land
49 partners

INTAROS educational package - terrestial monitoring

- Welcome to the Arctic
- Arctic observations
- Working in the Arctic
- Arctic career opportunities
- Want to be a polar resear...
- Wrap-up session

The Polish Polar Station in Hornsund is located in Isbjornhamna Bay of the Hornsund Fjord. It represents the southern part of the Norwegian Island of Spitsbergen, part of the Svalbard Archipelago.
This establishment conducts year-round scientific research (since 1978) and is the northern-most permanent Polish scientific site. It is managed by the Institute of Geophysics of the Polish Academy of Sciences, Warsaw.

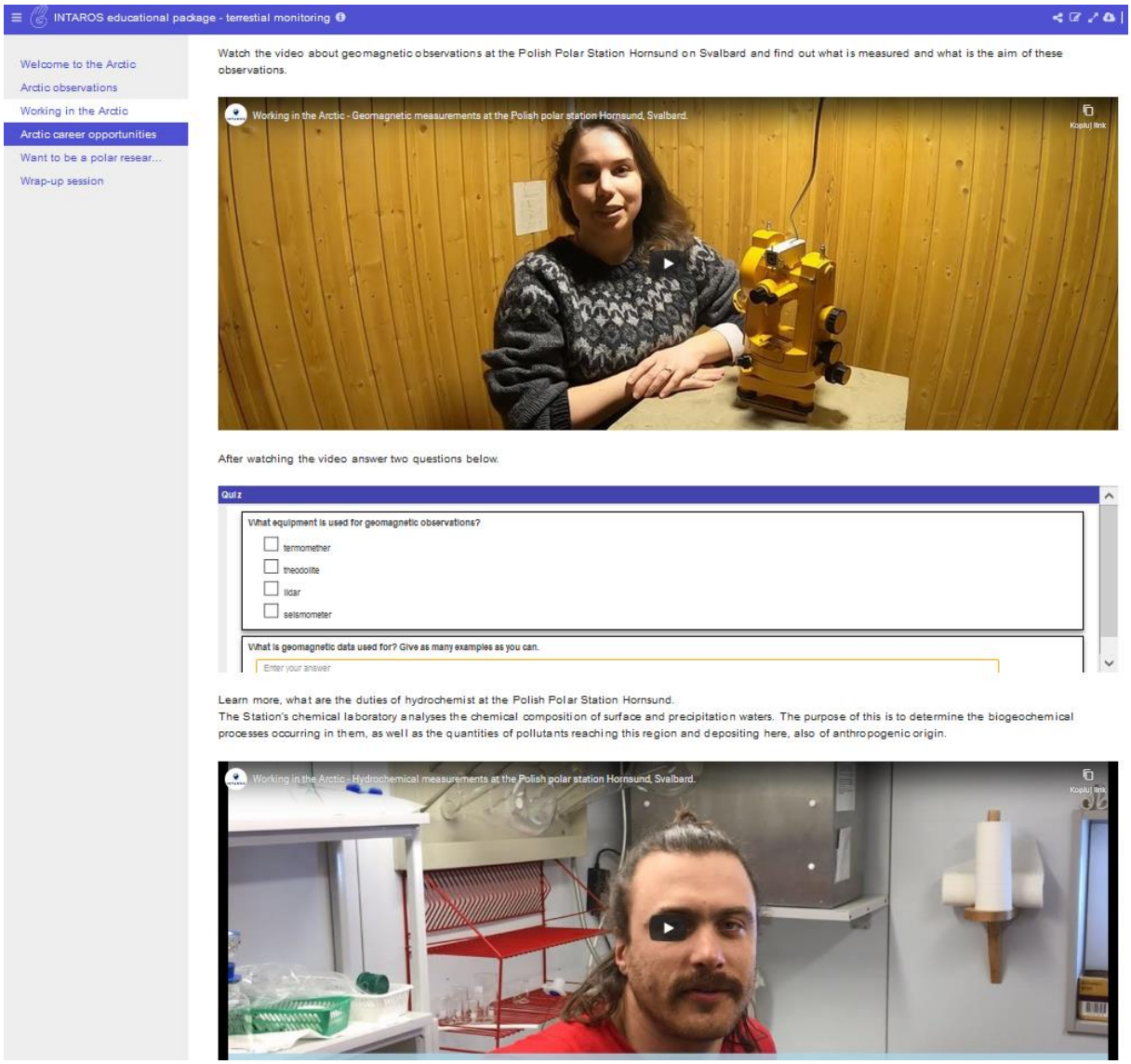
Year-round scientific research is conducted in the following fields:
Meteorology, Seismology, Earth magnetism, Ionospheric research, Glaciology, Atmospheric physics and optics, Environmental research.
If you want to know more about the research conducted there, click on "show scope of research" below.

Show Scope of research

What does a meteorologist do in the Arctic? What kind of measurements and observations are conducted in the Polish Polar Station Hornsund on Svalbard?

Once you watched the video, try to recall the main meteorological parameters measured or observed in Hornsund. Write them in the box below.

Type here


INTAROS educational package - terrestial monitoring
Welcome to the Arctic
Arctic observations
Working in the Arctic
Arctic career opportunities
Want to be a polar resear...
Wrap-up session
Watch the video about geomagnetic observations at the Polish Polar Station Hornsund on Svalbard and find out what is measured and what is the aim of these observations.
Working in the Arctic - Geomagnetic measurements at the Polish polar station Hornsund, Svalbard.
Kopiuj link
After watching the video answer two questions below.
Quiz
What equipment is used for geomagnetic observations?
termomether
theodolite
lidar
seismometer
What is geomagnetic data used for? Give as many examples as you can.
Enter your answer
Learn more, what are the duties of hydrochemist at the Polish Polar Station Hornsund.
The Station's chemical laboratory analyses the chemical composition of surface and precipitation waters. The purpose of this is to determine the biogeochemical processes occurring in them, as well as the quantities of pollutants reaching this region and depositing here, also of anthropogenic origin.
Working in the Arctic - Hydrochemical measurements at the Polish polar station Hornsund, Svalbard.
Kopiuj link

INTAROS educational package - terrestial monitoring

- Welcome to the Arctic
- Arctic observations
- Working in the Arctic
- Arctic career opportunities
- Want to be a polar resear...
- Wrap-up session

In the previous section you learned about work of meteorologist, geomagnetic observer and hydrochemist.

In this section you will learn about a few other career opportunities in the Arctic.

Glaciology is the study of snow and ice and their physical properties. Glaciologists analyze the formation, movement, and effects of the different kinds of glaciers and glaciation, for example mountain glaciers, ice caps, ice sheets, and ice shelves.

In a very varied area of glaciology research, there is a part hidden in the depths of the glaciers with glaciers - gaps, wells and internal drainage channels, very similar to karst caves. Like karst caves, ice caves require the use of specialized techniques taken from extreme sports such as climbing and speleology.

Polar regions are areas where processes of changing the surface of the Earth are very vivid. Therefore, they are great areas of investigation for geologists and geomorphologists.

INTAROS educational package - terrestial monitoring

- Welcome to the Arctic
- Arctic observations
- Working in the Arctic
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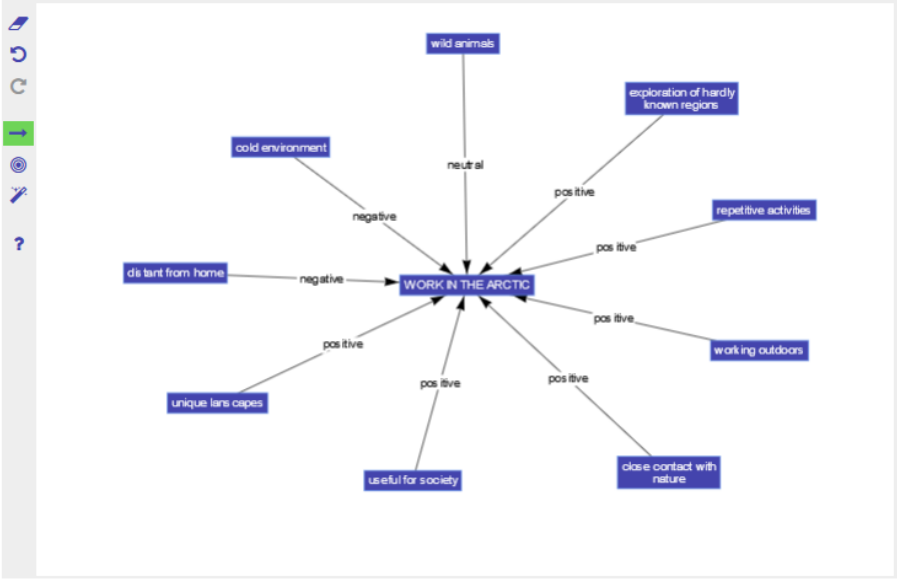
- Want to be a polar research...
- Wrap-up session

Let's step into the shoes of scientists for a little bit and think what are the advantages and drawbacks or challenges of working in polar regions. In the mind map below you may use provided concepts and add as many own ideas as come to your mind.

Then, decide if the concepts are positive (something that would encourage you to take such job), negative (something discouraging) or neutral. For some concepts you may decide that they might be both positive and negative (e.g. wild animals - it may be fascinating to observe wild species in the natural environment, but it is also dangerous to meet a polar bear). In such case you may add such concept twice and add explanations.

Concept Mapper



After each student prepared his/her concept map, you may want to discuss your findings with other colleagues. For this purpose teacher may divide you into groups, where you may share your ideas and opinions and try to summarize various answers.

Collaboration Tool

You are not a member of any collaboration group

Once you discussed the opinions on working conditions in the Arctic with your colleagues, you may prepare a short text explaining your point of view.

Would you like to work as a researcher in the Arctic? Why? Why not?

INTAROS educational package - terrestial monitoring

- Welcome to the Arctic
- Arctic observations
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- Wrap-up session

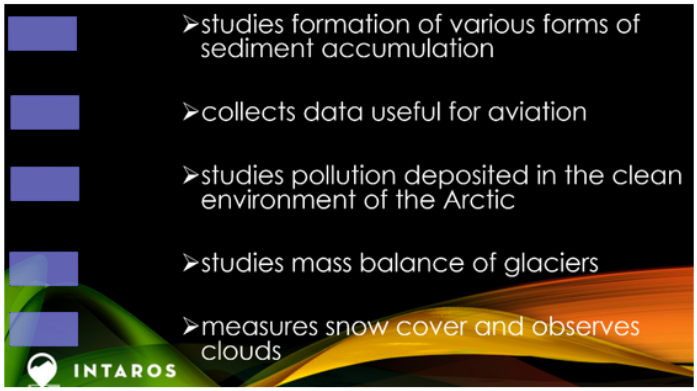
In this section you will have a chance to test yourselves and to express your feelings about the activity.

In the previous sections you learn about various jobs, which may be done at a polar station. Match the names of occupation with activities typical for each job.

Name The Frame

Drag and drop these names into the correct frames in the image. To check your answers, click on the check mark on the left.

meteorologist | glaciologist | geomorphologist | geomagnetic observer | hydrochemist



How did you like the activity?

Quiz

How did you like the activity? Indicate all answers that apply to your feelings about the task.

- ☐ I enjoyed it.
- ☐ I found it useful.
- ☐ I found it interesting.
- ☐ I found it boring.
- ☐ I knew everything before.
- ☐ I was pretty good at it.
- ☐ I felt nervous about it.
- ☐ Doing the task was fun.

Package 2 – marine monitoring

INTAROS educational package - marine monitoring

- Welcome to the Arctic Ocean
- Why sea ice is so important
- Marine monitoring
- Working in the field
- Let's play
- Wrap-up session

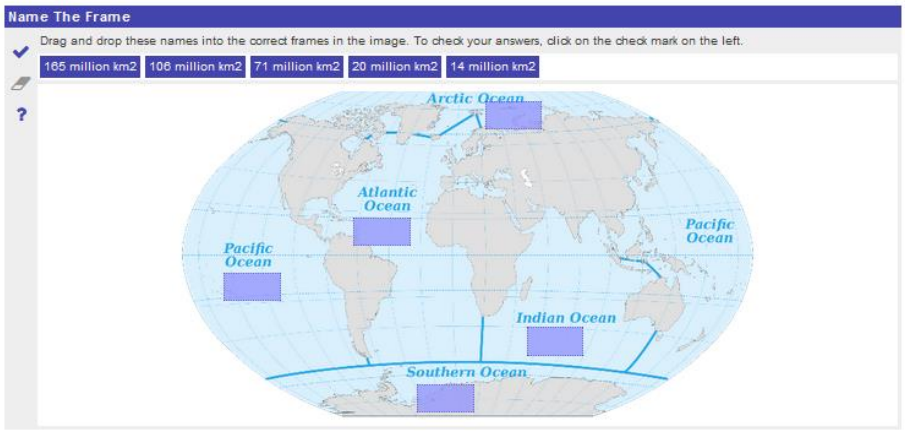
This educational material was created within the INTAROS project funded from the European Union's Horizon 2020 Research and Innovation Programme under GA No. 727890.

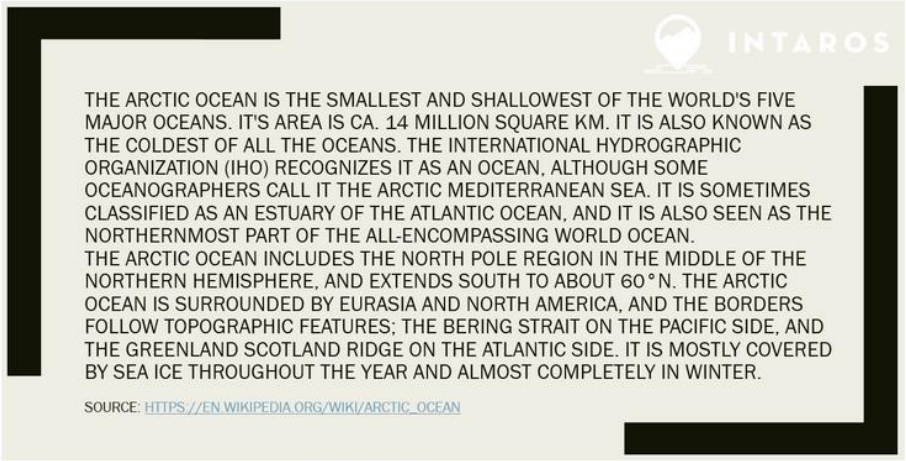
INTAROS

In this section you will learn about the Arctic Ocean. How big it is? What are its main features? Why is it so important for the whole globe?

The World Ocean or Global Ocean is the interconnected system of Earth's oceanic waters, and comprises five oceans. Check, if you know how big are the oceans. Once you drag and drop the areas of the oceans correctly, you may find out more by clicking on "i" icon.

The source of the map: https://commons.wikimedia.org/wiki/File:World_map_... author Pinpin



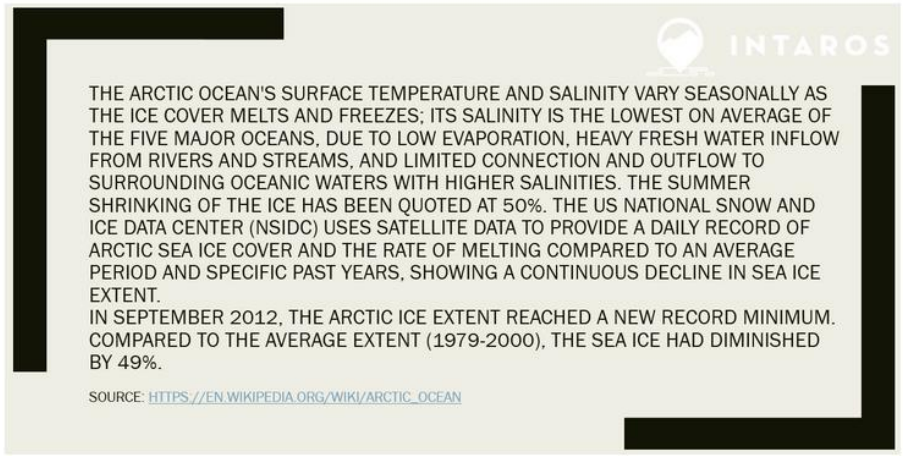


Map of the Arctic region showing the Northeast Passage, the Northern Sea Route and Northwest Passage, and bathymetry. By Susie Harder - Arctic Council - Arctic marine shipping assessment - http://www.arctic.noaa.gov/detect/documents /AMSA_2009_Report_2nd_print.pdf

- Welcome to the Arctic Ocean
- Why sea ice is so important
- Marine monitoring
- Working in the field
- Let's play
- Wrap-up session

Watch the video about the Arctic Ocean. Try to remember, why the Arctic Ocean is such an important ecosystem.

The coldest, windiest place on Earth holds 60 percent of the fresh water on the planet. Recent expeditions to the Weddell Sea produced more than 700 new species, including giant carnivorous sponges.



Watch the video and find out more about disappearing sea ice.

INTAROS educational package - marine monitoring

- Welcome to the Arctic Ocean
- Why sea ice is so important
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In this section you will find out why the Arctic Ocean observations are crucial for understanding the planet.

In the previous section you learnt how the sea ice extent is changing over years. Watching the video below, you will understand the consequences of the melting ice.

The Arctic may seem like a frozen and desolate environment where nothing ever changes. But the climate of this unique and remote region can be both an early indicator of the climate of the rest of the Earth and a driver for weather patterns across the globe. William Chapman explains why scientists often describe the Arctic as the "canary in the coal mine" when it comes to climate change.

Lesson by William Chapman, animation by Sandro Katamashvili.

Watching the video, you heard that melting of sea ice brings various cosequences. There are both: positive and negative feedback loops.

Melting sea ice increases the moisture and helps formulating clouds. This is an example of negative feedback loop. However, the system is not in equilibrium. How do you think, why? Explain in the box below

Type here

INTAROS educational package - marine monitoring

- Welcome to the Arctic Ocean
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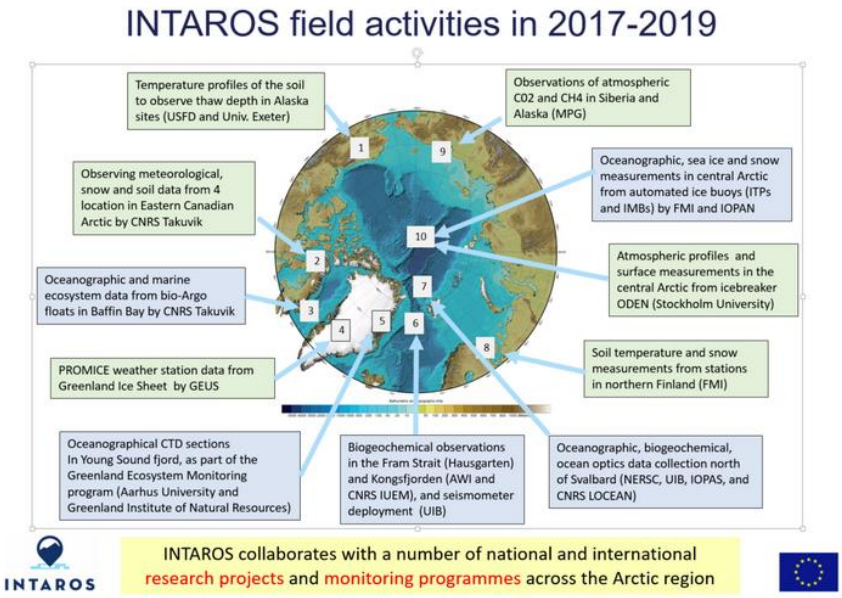
In this section you will learn about the oceanographic measurements and observations conducted in the Arctic. Would you like to become an Arctic explorer?

Look at the infographic about field activities conducted within the INTAROS project. Oceanographical measurements and observations are described in blue boxes.



This is a teaser about the 17 scientists heading north of Svalbard with the Norwegian icebreaker KV Svalbard in September 2018. Their goal was deploy moorings heavily equipped with instruments to measure ocean temperature, salinity, and chemical properties for 1-2 years. These measurements are important for monitoring changes in the Atlantic water flowing into the Arctic Ocean. During the cruise the scientists were carrying out light and turbulence measurements in the ocean under the ice, in open ocean, and near ice shelves. Changes in the ocean properties and processes will influence the ecosystems in this region. In this way the INTAROS project contributes with important observations from the sparsely sampled ocean North of Svalbard.

After watching the video, explain, if you would like to take part in such an expedition. Why? Why not? Support your opinion with precise reasons.

Type here

INTAROS educational package - marine monitoring

- Welcome to the Arctic Ocean
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In this section you will learn, how marine monitoring is conducted in Greenland. One of the scientists will take you on a journey by boat and describe the measurements and observations, which are conducted.

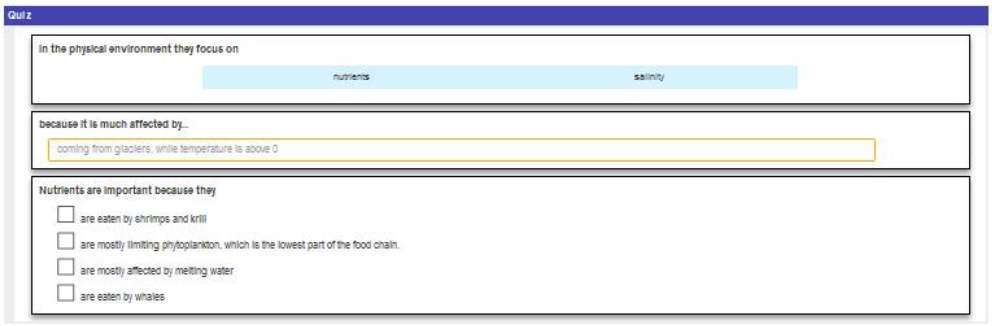
But first watch a short video about the largest island on planet.

Watch the video about marine monitoring in Greenland - described by Thomas Juul Pedersen, senior scientist at the Greenland Climate Research Centre and the Greenland Institute of Natural Resources.

Try to remember important parameters measured by researchers.

Watch the video about marine monitoring in Greenland - described by Thomas Juul Pedersen, senior scientist at the Greenland Climate Research Centre and the Greenland Institute of Natural Resources.
Try to remember important parameters measured by researchers.

After watching the video about measurements and observations conducted by Greenlandic researchers answer three questions below.



INTAROS educational package - marine monitoring

- Welcome to the Arctic Ocean
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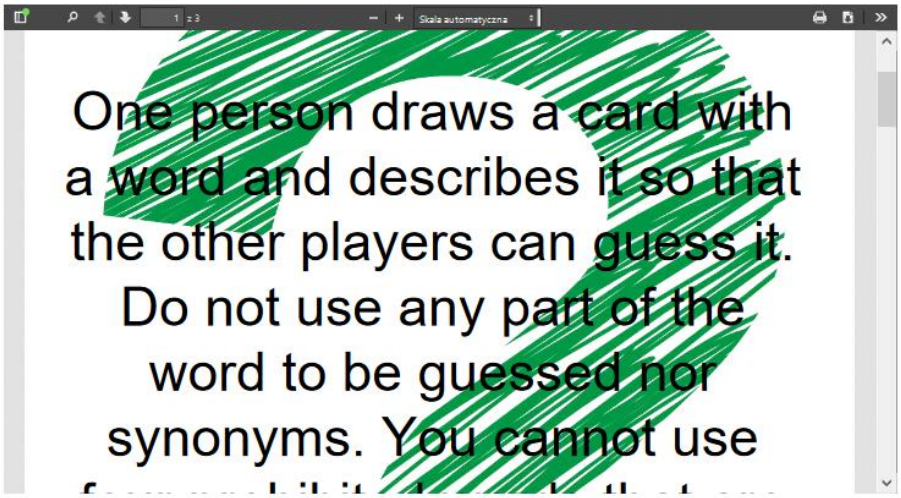
Do you know TABOO game? Have you ever played it before?

TABOO rules: One person draws a card with a word and describes it so that the other players can guess it. Do not use any part of the word to be guessed nor synonyms. You cannot use four prohibited words that are on the card under the main word.

18 arctic passwords to be guessed!

You may print the pages and cut them into 18 pieces. Then, distribute the cards to playing teams.



If you cannot play TABOO in the classroom, you may do another excercize using the cards above.

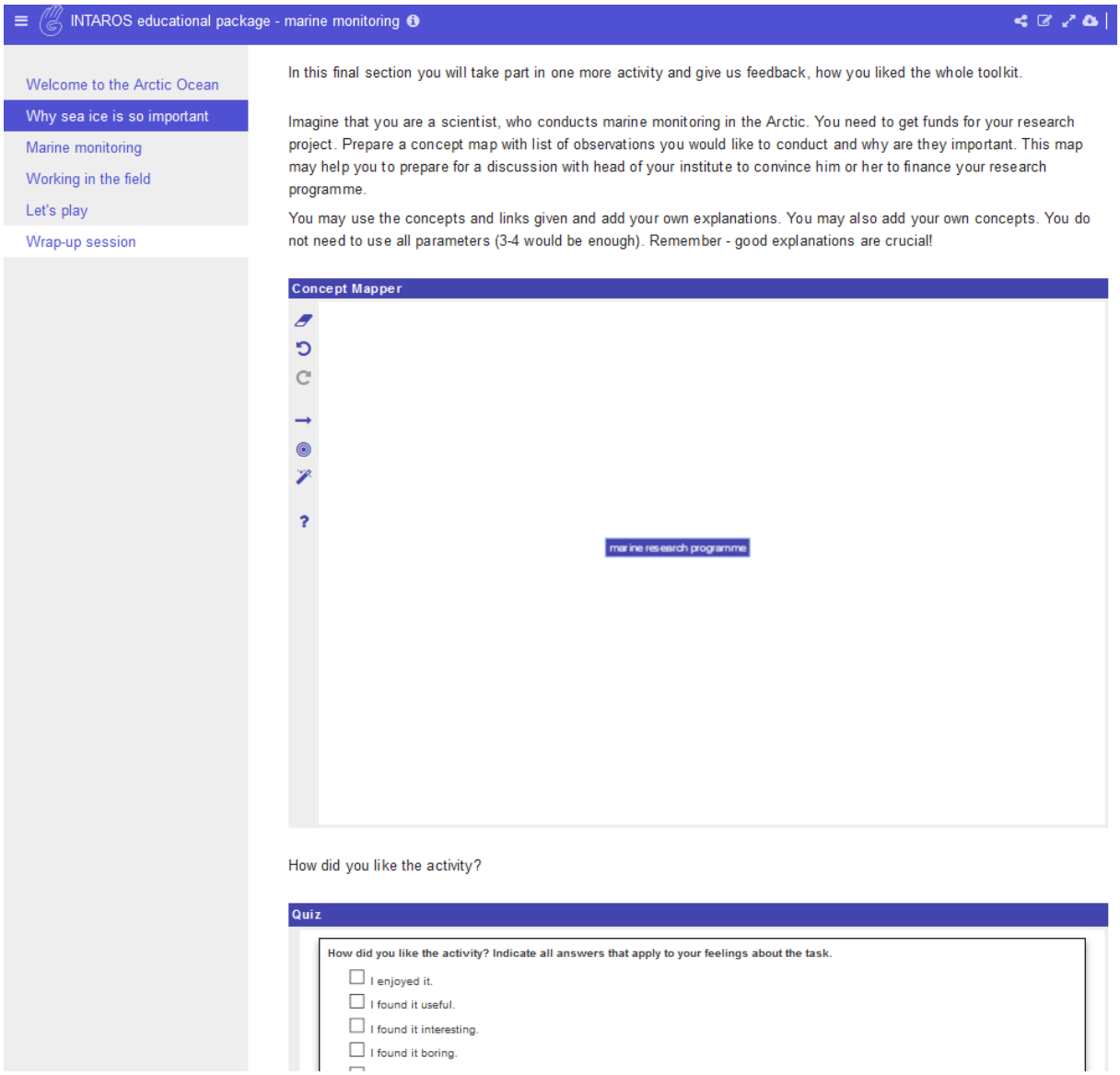
Draw three cards and try to give explanations to given words (1-2 sentences per each password) not using the forbidden words. Write the explanations in the box below.

Type here

Another way of using the cards above is to do it as homework or extra activity. Students are drawing a few (2-3) cards and recording their explanations (e.g. with the use of mobile phone). Each explanation shouldn't be longer than 20 seconds. Then, they upload the video below.

In the classroom you may then broadcast the videos and guess the passwords.

Remember not to read all cards - use only yours!



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INTAROS

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