SPACE awareness

NAVIGATION THROUGH THE AGES

TOOLS AND TERMS

WHAT IS TIME?

ANA HOSKINS

SARA ANJOS

www.space-awareness.org

Information about the course

Curriculum topic: time, coordinate systems, cardinal points

Category: Navigation through the ages

Keywords: time, navigation, satellite, GNSS, EGNOS, Galileo

Education level: Primary

Language: English

Age range: 8–12 years

Didactical hours: 2 didactical hours

BRIEF DESCRIPTION

After watching introductory videos, the students perform an activity that helps them identify concepts, tools, and terms that are essential for the determination of time. They learn about the basics of how satellite navigation works and about GNSSs, that is, global navigation satellite systems, and their uses and purposes, focussing on Galileo.

EDUCATIONAL OBJECTIVES

- To use space and the Universe to broaden children's minds, develop a sense of European and global citizenship, and foster tolerance for diverse cultures
- To attract the interest of students, mainly European, for space exploration, science, and technology
- To trace the history of navigation, from ancient Greek and the fifteenth century European explorers and their missions of global discovery to Europe's Galileo programme and the current needs of citizens (mobile devices, increased mobility, safety and security, etc.).

Cognitive Objectives: Types of Knowledge	Cognitive Objectives: Processes	Affective Objectives	Psychomotor Objectives
Factual	To remember	To pay attention	To imitate and try
Conceptual	To understand	To respond and participate	To perform confidently following instructions
Procedural	To apply	To recognise values	To perform independently, skilfully, and precisely
Meta-cognitive	To think critically and creatively	To form and follow a system of values	To adapt and perform creatively

Please briefly explain how each educational objective is achieved by the activity.

STEPS

ORIENTATION

Start the activity by showing a video and then discussing the theme of the video.

See the following video:

Video: LBS – Faster fix, improved location.

https://www.youtube.com/watch?v=8_5T1FwQPZc&list=PLoW55g8cihhLcnWXFbi75Qezlwc61ExX6&index=1

"What is the video about?"

Ask your students what the video is about.

They should come up with ideas about how time is important in everyone's life.

"How important is to know the time?

How can we measure time?

Can you tell what time it is without agreeing on some things beforehand?"

Start a discussion that will lead the classroom to these two important questions:

"What is time?

How can we tell the time if we don't have a watch?"

Now that the students have an initial idea of what this activity is about, you can present the goal of the activity.

EXTRA GUIDELINES

Tips for a diverse classroom

- Invite all students to contribute to the discussion.
- Invite all of them to participate in the game. You may encourage several games.

Main skills involved

- Active listening - Paying complete attention to the teacher while the game is presented.
- Active learning
- Time management
- Social perceptiveness

CONCEPTUALISATION

Questions

Students can decide to find the answers for these two questions.
At this point, students will discuss both questions on the basis of the knowledge they've acquired from watching the video and their previous knowledge about the subject.

To help them with this task, you can ask them how the subject (time) is related to GNSS and GALILEO.

"What is time?

How can we tell the time if we don't have a watch?"

Hypothesis

Ask students to pose hypotheses for the questions they have framed. You may write their hypotheses in Padlet or share them on Wiggio.

Encourage your students to speak their mind even if they are hesitant. Explain to them that everyone make mistakes.

"Do you have any answers to the questions you framed?

Let's share ideas.

A scientific question or problem can be solved by trying to make rational guesses about the answer. These are known as hypotheses. The hypotheses should be tested through experimentation. If a hypothesis is wrong, then we should try another 'guess' after the experiment or some research. Now let's see if there is any hypothesis to test."

EXTRA GUIDELINES

Tips for a diverse classroom

- Make sure that there are no gender monopolies. Make sure that all students are given time and space to design their hypotheses.
- Treat all questions and hypotheses seriously.
- Encourage everyone to expresses views and concerns.
- If you have students with special needs, try to adapt the activity such that everyone can be included.

Suggested ICT tools

At this part of the activity, you can use the Padlet (http://padlet.com/) tool as an online blackboard to write down the students' research questions. You can use a projector and

type the questions the students mention. You can also use the Wiggio (http://wiggio.com/) tool to encourage students to talk between groups.

Main skills involved

- Critical thinking - Using logic and reasoning to identify the key points of the game and research activity.
- Use of science – Referring to previous knowledge and scientific rules related to the activity.

INVESTIGATION

Exploration

At this point of the activity, students will design their research. You can suggest that they do the following activity.

Organise the children into pairs.

Game

Phase 1: Explain that they are going to see how long 1 minute takes. Give student A a stopwatch. Student A gives a signal when he/she starts the stopwatch. When student B thinks that 1 minute has passed, he/she gives a signal and student A stops the stopwatch. How much time does the stopwatch show?

Phase 2: Explain that they are going to repeat the experiment.
Now they have to think of a way to help them make a more accurate estimate of when 1 minute has passed. They could count or draw lines. Encourage the students to try out their suggestions. Then discuss how successful the experiment was. Were they able to make a better estimate the second time? What did they use to help them?

Ask why they think it is important to know how much time has passed. And why is it important to make agreements about time? Come to the conclusion that it is important that everyone uses the same definition when they refer to time. Thus, we can be sure to arrive on time for an appointment, for example.

"In order to answer our questions and test our hypotheses, we will need to plan some research. We will form groups to design our research and to do an activity.

TASK 1

Let's find out how long 1 minute takes!

In this activity, we will play a simple game to learn more about the determination of time.

TASK 2

Let's make an hourglass and a sundial!"

Ask the question "What ways of measuring time do you know about?"

Tell them to imagine that the next lesson will be in 5 minutes.

How would they know when the lesson will start if they don't have a watch?

If necessary, add the following to their ideas: looking at the position of the sun or using an hourglass (egg timer).

At this time, you can divide the class into two big groups: the first will make an hourglass and the second will make a sundial. The students in each group will be organised in pairs.

Group 1 will make an hourglass.

Ask the students to watch the next video: https://www.youtube.com/watch?v=0T2uYgreTR0

Then let them look at the material you have placed in advance on the working table.

They can now discuss how they are going to make their own hourglass. They will decide on the design and materials they will use. They will also draw a picture of their ideal hourglass.

Group 2 will make a sundial.

Ask the students to watch the next video: https://www.youtube.com/watch?v=CQViTzK0AsA

Then let them look at the material you have placed in advance on the working table.

They can now discuss how they are going to make their own sundial. They will decide on the design and materials they will use. They will also draw a picture of their ideal sundial.

Both groups must be explained that they need to make an hourglass/sundial in order to track the time in minutes. If they are unsure of how to proceed, you can help them by asking questions like 'Do you think you can count 5 minutes with your hourglass/sundial?'; 'What do you have to change?'

TASK 3A

How accurate is your hourglass?

Let's try it!

Choose a specific quantity of sand/water and a specific size for the hole.

The students test their hourglasses to see if they work properly.

Take the students to the playground and encourage them to use their own hourglass to measure how long it takes them to run a certain distance. Mark a start and finish line. One student from each pair gets ready to run. The other student waits for the starting signal, and then turns over the hourglass. How long did it take for the runner to cross the finish line? Could they measure it with their hourglass? Was there enough sand to measure the time? Ask the students to swap places and repeat the task.

Each hourglass will take a different length of time to empty. Explain that this has to do with the size of the hole they made and the amount of sand they used.

Discuss this task

Come to the conclusion that it is difficult to measure the exact time with an hourglass. If the hourglass is only partially empty, you can only guess how much time has passed.

Students should realise that each hourglass can make different measurements.

Ensure that students understand that by changing the quantity of sand/water and/or changing the size of the hole they make, they will get different measurements for the same timeline.

Make them take the measurements by changing the variables (amount of sand/water and size of the hole) three or four times.

TASK 3B

How accurate is your sundial?

Let's try it!

The students test their sundial to see if it works properly.
They can go outside or stay in the classroom. They just have to find a spot where there is sunlight.
Outside, they can use the sundial to measure how long it takes them to run a certain distance. For this, they will need to measure minutes using their sundial. Mark a start and finish line. One student from each pair gets ready to run. The other student gives the starting signal and keeps track of the time by looking at the sundial, until the first student finishes running.
How long did it take for the student to cross the finish line? Could they measure it with their sundial? Was it enough to have a sundial in minutes? Ask the children to swap places and repeat the task.

Discuss this task.

Come to the conclusion that it is difficult to measure the exact time with a sundial. Depending on your task, you will need to measure hours, minutes or even seconds. So you will need a more accurate sundial.

How this activity is related to the GNSSs?

How do you think that determining time is related to how GNSSs work?

Visit the following site: http://education.nationalgeographic.org/encyclopedia/gps/

EXTRA GUIDELINES

Tips for a diverse classroom

- Develop a positive atmosphere in the classroom that promotes excellence and cooperation.
- Encourage your students (as a group or individually) to consult you if they have problems during the activity.
- Encourage the formation of heterogeneous groups across certain characteristics such as gender, race, and level of achievement. You may choose to assign students randomly or ask them to form their own groups.
- Pay attention to the length of time students remain in a group.
- Make sure that boys and girls are equally engaged with the theme. You may encourage this by using examples from daily life that are common for both genders.
- Be sure to repeat the instructions if you think someone still has doubts. Be very clear in your instructions, so everyone knows what to do next and feels part of the task.

Related careers

Each stage of development of GNSSs involves several scientists, engineers, and technicians. You can ask your pupils what they think about this, and they can watch some more of the LBS videos online.

Main skills involved

- Complex problem solving – Understanding the research questions
- Critical thinking – Using logic and reasoning to understand the investigation plan and its implementation. Proposing modifications if necessary and assessing the validity of data received and the final results of data interpretation.
- Judgment and decision making – Considering possible pathways for recognising errors in the experimentation and data manipulation processes. Assessing teammates' proposals and opinions.
- Active listening – Paying full attention to the opinions of teammates.
- Reading and comprehension – Understanding instructions and the relevant theory.
- Monitoring – Assessing self-performance and team performance and taking corrective actions if needed.
- Active learning – Understanding the implementation process and its relation to the problem at hand. Relating information derived from experimentation and data interpretation to knowledge acquired previously and to the problem at hand.
- Time management – Managing the experimentation duration and not letting the team spend more time than foreseen on the task at hand.
- Systems analysis – Understanding the experimental set-up and how each variable affects the experiment. Manipulating and interpreting the data received.

- Coordination – Ensuring cooperation within teams and consequently, harmonious and balanced collaboration.
- Social perceptiveness – Being aware of teammates' reactions and understanding why they react as they do.
- Use of science – Using scientific rules and methods effectively to perform experiments and data interpretation.
- Systems evaluation – Assessing the experimentation process and understanding whether the experiment has been carried out correctly or not. Being able to take the actions needed to improve or correct performance.
- Use of mathematics – Using mathematics to manipulate data and produce final results.
- Quality control analysis – Assessing the results derived as well as the quality of the gathered data. Being able to identify the source of error involved in the experimentation.

Suggested ICT tools

- Research tools (Wikipedia)
- Videos:
    - https://www.youtube.com/watch?v=-j-SWKtWEcU
    - http://www.youtube.com/watch?v=widWLhllbzs
- Web links on how GPS or GNSSs work
    - US Coast Guard Navigation Centre
      http://www.navcen.uscg.gov
    - EGNOS resources:
      http://www.esa.int/navigation/egnos-pro
    - Galileo website (European Commission)
      http://ec.europa.eu/galileo
    - European GNSS Agency, GSA
      http://www.gsa.europa.eu
    - Institute of Engineering, Surveying and Space Geodesy, University of Nottingham
      www.nottingham.ac.uk/iessg
    - Space Academy
      www.spacecentre.co.uk/education
    - National Corn Growers Association satellite science
      www.ncga.com/education/unit5/u5l3.html
      http://oceanservice.noaa.gov/education/lessons/meet_geodesy.html
- Wiggio, Padlet or Moodle to organise their research
- Dropbox or Google Docs (for storing their investigation sheets)

CONCLUSION

"Prepare a report about the activity you performed."

Encourage students to share their conclusions via a report.

EXTRA GUIDELINES

Suggested ICT tools

Tools that could be useful in the conclusion phase are as follows:

- Research tools (Wikipedia)
- Online collaboration documents for sharing inputs and ideas (Google Docs)
- Shared space (Dropbox)
- Virtual classroom walls (Padlet, Popplet, Moodle, Spiral) (for reflecting on the conceptualisation phase)
- Study cards (Studyblue) (for reflecting on the conceptualisation phase)

Tips for a diverse classroom and ensuring gender balance

- Encourage students to include multiple perspectives and consider alternative explanations.
- Don't allow students to be interrupted or intimidated.
- Encourage hesitant students to speak their mind and show them you are especially interested in what they have to say.
- Give students time to draw their conclusions and be sure that you are paying attention to all of them equally.
- Refer to a silent student's work in an affirming way.
- Credit a quiet student by making her or him the expert for part of the task.
- Ask all students to take turns in coming up with conclusions.

Main skills involved

- Active listening
- Reading and comprehension
- Speaking
- Active learning
- Time management
- Writing
- Social perceptiveness

DISCUSSION

Communication

"Use the data on the report to describe and explain the steps you have been through and the discoveries you made to other students and to people outside school (your friends or relatives, for instance)."

At this time, the entire class presents its findings and each group comments on the work of other groups.

Reflection

"See the following videos and think about the uses of satellite navigation in your daily life.

The many uses of Galileo and EGNOS today and tomorrow

http://www.gsc-europa.eu/the-many-uses-of-galileo-and-egnos-today-and-tomorrowm

About GSA

The European GNSS Agency: Linking space to user needs

http://www.gsa.europa.eu/gsa/about-gsa"

Show the videos to your students:

- The many uses of Galileo and EGNOS today and tomorrow
  http://www.gsc-europa.eu/the-many-uses-of-galileo-and-egnos-today-and-tomorrow
- About GSA - The European GNSS Agency: Linking space to user needs
  http://www.gsa.europa.eu/gsa/about-gsa

Encourage your students to reflect on the uses of satellite navigation.

Discuss with them what they have learnt and the importance of this investigation to know more about satellite navigation systems.

Help them identify how they can share their findings with others (share information on social media, write a blog, build an exhibit, organise an event for the entire community including relatives and friends, etc.).

EXTRA GUIDELINES

Suggested ICT tools

- Different presentation tools can help the students make creative and inspiring presentations. Depending on the timeframe of the activity, students may prepare a simple presentation using tools like Powerpoint or ones that require the use of complex tools like movie-making tools.
- Presentation tools (MS PowerPoint, Open Office Impress, Prezi)
- Story-making tools (Storybird)
- Word clouds (Wordle)
- Movie- and animation-making tools (Windows Movie Maker, Animoto)
- Blogging tools (Blogger, Wordpress, Spiral, Wiggio)
- Photo-sharing and editing tools (Picasa, Instagram, Snapchat, Flickr, Photobucket)

Tips for a diverse classroom and ensuring gender balance

- Allow the presentation of multiple opinions and perspectives.
- Use examples from multiple backgrounds and perspectives.
- Be sensitive to cultural differences in writing styles, recognising that many standards apply to the evaluation of good writing and presenting.
- Be explicit about what is expected and show examples of good writing done by other students.
- Respect the different opinions of students.
- Be sensitive to the experiences of visibly underrepresented students in your class.

Main skills involved

- Active listening
- Reading and comprehension
- Speaking
- Active learning
- Time management
- Writing
- Social perceptiveness

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