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Earth Observation for Earth System Science Education: the MICE activity

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Abstract

Developing educational material based on satellite remote sensing technologies, information and methods, is a key trend in modern pedagogy of Earth System Sciences. Here, we present "MICE", a classroom activity on **M**elting **IC**e **E**ffects, that utilizes remote sensing information to demonstrate the value of Earth Observation (EO) as a context to teach the STEM (Science, Technology, Engineering and Mathematics) school curriculum. The activity focuses on the subject of polar ice melting as a main climate change effect and the different impact of land and sea ice melting on sea level rise. Students, have the opportunity to discover the above experimentally and subsequently, to observe the diachronic change on polar ice through sequences of satellite images and discover the positive climate feedback on global warming. The activity was translated and adapted to the Greek curriculum from the freely available classroom resources of the European Space Agency (ESA, "Teach with Space" collection). MICE, has been enriched with Greek scientific material, including up-to-date information on climate impacts, localized for the extended region. As part of an evolutionary process, the activity was pilot-tested with 6th grade primary school students and adjusted according to the trial findings. This work is considered as the first step towards the development of original Greek educational material that will utilize EO and climate change as the context to teach STEM school curriculum, capitalizing on the pedagogical role satellite remote sensing and inquiry-based teaching methods, can play.

Introduction

Recent trends in Science Education include the development of modern educational techniques and material to teach the STEM school curriculum. At the European level, the main instrument to provide space-related material to the primary and secondary education community is the European Space Education Resource Office (ESERO) of ESA. ESERO aims at bringing Earth Observation (among other themes) to the classroom, by targeting mainly the teachers' community, as the key actors for realizing qualitative STEM education. Towards this goal, ESERO supports the education community by providing material and classroom resources based on Earth Observation (EO) and geared towards science. One of the venues used by ESERO to effectively disseminate the modern educational material towards the teachers are the annually-organized "ESA summer and autumn teacher workshops". These workshops are inspired by real and actual ESA space missions and programmes to provide teachers with unique material demonstrating how space can be utilized to teach STEM curricular subjects in school.

In the same context, the European Copernicus EO Programme acts as an effective multiplier for the development and optimization of EO-related education activities, through the provision of free information content and advanced IT open resources that can directly impact teaching and learning systems by providing insights of our planet, never available before. The incorporation of Copernicus data and information in all levels of education is an ongoing effort which has been initiated with the establishment of the Copernicus Academy Network.

Both the tools and information content provided by Copernicus and the ESA-ESERO educational materials and resources, need translation and proper adaptation to the Greek educational ecosystem and curriculum. Here, we demonstrate such an adaptation of an ESERO educational activity for Greece. In the following paragraphs we provide an overview of the activity and the conclusions drawn from its pilot application.

Activity description and pilot application

As a starting point for the development of the educational activity, we applied a bottom-up approach to gather the teachers' views, needs and interests on the subject EO utilization in STEM education. For this purpose, we constructed a survey, gathering educators' opinions on (a) the preferred activities' duration (short 20'-30' or longer 90' and above), (b) the preferred activities' morphology (worksheet based, multimedia based, experiment based, etc.) and (c) the preferred subjects of interest as far as natural or man-made disasters are concerned. The mapping process of educators' views, requirements, needs and subjects of interest, is an on-going one, aiming to acquire an extended sample over time and to record related trends.

The sample of teachers is drawn from the schools visiting the three museums of the faculty of Geology and Geoenvironment of NKUA (Mineralogy and Petrology Museum, Paleontology Museum and the Zoological Museum). Visiting Schools come from all over the Attika region and ever further away. Based on the preliminary results of the teachers' survey, climate change and subsequent impacts (melting polar ice, sea level rise, greenhouse effect) are high on teachers' preferences.

This survey drove us to select an existing thematically-related classroom activity from the freely available ESA classroom

resources, entitled “The ice is melting – How can we investigate the effects of melting ice” (ESA-ESERO, 2017), as a starting point for utilizing best practices and space-related themes for teaching Earth System Sciences.

Following that, the activity was translated to Greek and linked to the Greek curriculum (following Antoniou et al., 2014). Then it was enriched with Greek pedagogical and scientific content both on the student worksheets and the teacher’s guide. Up-to-date information on climate change issues has been integrated from the latest report of the Intergovernmental Panel on Climate Change (IPCC), including information on the expected climate imparts over Greece (Guilyardi et al., 2018; Zerefos, 2011). As a next step, the activity was pilot tested with two classes of 6th grade students (42 students in total) from the 4th primary school of Geraka. Pupils worked in groups of 4 for 90’ in total. This pilot application provided important feedback that helped us review and improve the material as discussed in the next section.

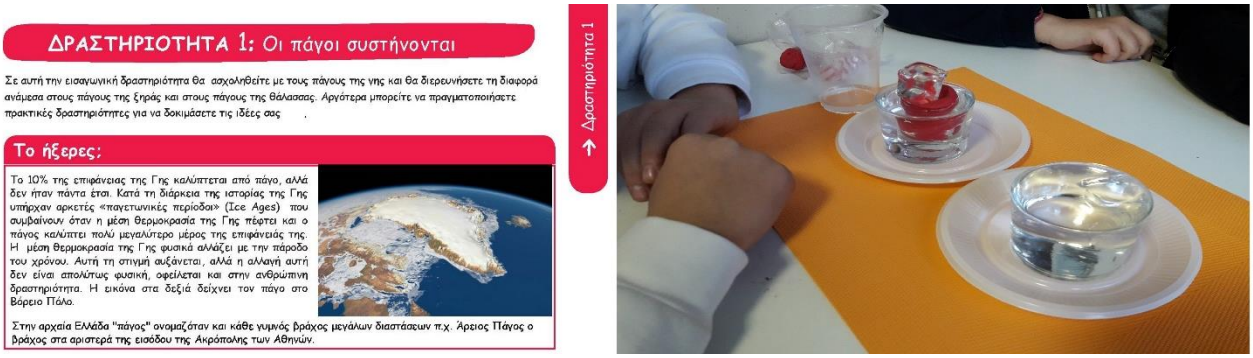

Figure 1. Sample from the MICE activity (left) and the student trials (right)

Discussion and Conclusions

Based on the pilot trial findings, we conclude that the MICE’s cognitive goals are successfully achieved in the classroom, while students’ interest is maintained at a high level. The use of satellite images as learning tools throughout the student worksheets, found to have a positive effect on deeper comprehension of the physical processes involved at a global scale. At the same time, the use of diachronic archives of satellite imagery, facilitated better understanding of the dynamic evolution of such phenomena under climate change (Galani, 2016). As far as the evolution of the activity per se, the student trials provided valuable practical feedback that has already been incorporated in order to improve the material, such as revised teacher guidelines and other practical alterations for ensuring the success of the experiments and other hands-on exercises.

These encouraging trial results along with the teachers’ positive survey feedbacks, paves the way for the development of similar material to address more Earth System Science phenomena, focusing on hot topics such as climate change and natural disasters (e.g. floods, forest fires, oil spills, algal blooms, desert dust outbreaks, volcanic eruptions etc.).

ESA ESERO thematic educational material, along with the free and open information, data and tools provided by the Copernicus ecosystem, provide a first-class opportunity for educational exploitation of these resources.

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