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# Astrobiology and Society in Europe Today

**Klara Anna Capova** (1), Erik Persson (2), Tony Milligan (3) and David Duner (4)
(1) Department of Anthropology, Durham University, UK (k.a.capova@durham.ac.uk) (2) The Pufendorf Institute for Advanced Studies, Lund University, Sweden (3) Department of Theology and Religious Studies, King's College London, UK (4) Department of Arts and Cultural Sciences, Lund University, Sweden

## Abstract

The poster entitled ' Astrobiology and Society in Europe Today: The White Paper on ethical, societal and political consequences of astrobiology research' gives an outline of a recently completed joint work of Working Group 5 Philosophy and History of Astrobiology, a part of a Trans-Domain European COST Action Life-ORIGINS TD1308 Origins and evolution of life on Earth and in the Universe. With contributions from authors in twenty countries and over thirty scientific institutions worldwide, the document illustrates the societal implications of astrobiology and the positive contribution that astrobiology can make to European society.

## 1. Introduction

The poster introduces the White Paper on societal implications of astrobiology research in European context and its relation to society at large. Astrobiology is inherently interdisciplinary and based on collaboration between disciplines, universities and countries. For Europe to take a leading role in this research, it is very important to have a stable structure that can coordinate research, research infrastructure, funding and relations to the surrounding society in an efficient way. In detail, the poster highlights the two main objectives of the Astrobiology and Society White Paper:
(1) It recommends the establishment of a European Astrobiology Institute (EAI) as an answer to a series of challenges relating to astrobiology but also European research, education and the society.
(2) It also acknowledges the societal implications of astrobiology, and thus the role of the social sciences and humanities in optimizing the positive contribution that astrobiology can make to the lives of the people of Europe and the challenges they face.

## 2. Poster Outline

With the aim of the poster is to inform space science professionals as well as interested public about the document, the poster provides overview of sections related to contributions of astrobiology to society, advancement of science in Europe, environmental protection, as well as societal challenges from astrobiology, and potential conflicts of interest between astrobiology and commercial use of space. Furthermore, the poster aims to point out to the timely role of an organised initiative in astrobiology education and popularisation of science.

## Acknowledgements

We would like to acknowledge the support of COST Action TD1308 ORIGINS, namely through the Short Term Scientific Mission (STSM) fundings: STSM- TD1308-010216-070847, STSM-TD1308-121216-081651, STSM-TD1308-1604180-40883 and STSM-TD1308-150418-040842. Further, the support of the Pufendorf Institute for Advanced Studies at Lund University, Sweden, through the 'A Plurality of Lives' research theme. The WP editors would also like to thank the authors and the international advisory board for contributing to this joint document.

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# Danakil Depression:
# A natural laboratory as a vehicle for astrobiology outreach

Anastasia Kokori

DCU, Dublin, Ireland (anastasia.kokori@gmail.com)

## Abstract

The Danakil Depression is a real world laboratory and astrobiological research is carried out due to the extreme conditions of the area. The place could be considered as a real life simulation of extreme environments on other worlds, and show to the public the extreme conditions under which life can survive. The geomorphology of Danakil Depression, combined with the newly introduced astrobiological research, indicate that there is a great potential for science learning in different disciplines in the area. In this presentation, I will explore how we can engage the public, and communicate scientific information successfully in the case of Danakil Depression. Natural places such as the Danakil Depression can be an effective arena to raise awareness and engage the general society with contemporary research such as life in extreme environments.

In order to increase reliability and validity in the study, I used a variety of sources for data collection: interviews, documents and media artefacts. The results revealed the importance of various strategies and the involvement of multiple stakeholders for effective astrobiology communication in extreme environments - such as the Danakil Depression. The findings of the study, the potential challenges and also recommendations for interested stakeholders (scientists, policy makers and educators) will be discussed. This case study can provide examples for astrobiology outreach not only for Danakil Depression but also for other planetary analogues or real world laboratories.

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# Astrobiology and Society in Europe Today

**Klara Anna Capova** (1), Erik Persson (2), Tony Milligan (3) and David Duner (4)
(1) Department of Anthropology, Durham University, UK (k.a.capova@durham.ac.uk) (2) The Pufendorf Institute for Advanced Studies, Lund University, Sweden (3) Department of Theology and Religious Studies, King's College London, UK (4) Department of Arts and Cultural Sciences, Lund University, Sweden

## Abstract

The talk entitled 'Astrobiology and Society in Europe Today. The White Paper on the societal implications of astrobiology research in Europe and the need for a European Astrobiology Institute' gives an outline of a recently completed joint work of Working Group 5 Philosophy and History of Astrobiology, a part of a Trans-Domain European COST Action Life-ORIGINS TD1308 Origins and evolution of life on Earth and in the Universe.

With contributions from authors in twenty-five countries and over thirty scientific institutions worldwide, on societal implications of astrobiology research in European context and its relation to society at large.

## 1. Introduction

Astrobiology enjoys a great deal of interest among the public, probably more than most other fields of research. It also has implications for human life outside laboratories and lecture halls. It has the potential to be a flagship of European cooperation in science.

Astrobiology is inherently interdisciplinary and based on collaboration between disciplines, universities and countries. For Europe to take a leading role in this research, it is very important to have a stable structure that can coordinate research, research infrastructure, funding and relations to the surrounding society in an efficient way. In detail, during the talk will be introduced the two main objectives of the Astrobiology and Society White Paper:
(1) It recommends the establishment of a European Astrobiology Institute (EAI) as an answer to a series of challenges relating to astrobiology but also European research, education and the society.
(2) It also acknowledges the societal implications of astrobiology, and thus the role of the social sciences and humanities in optimizing the positive contribution that astrobiology can make to the lives of the people of Europe and the challenges they face.

## 2. Poster Outline

With the aim to inform space science professionals as well as interested public about the White Paper, the sections related to contributions of astrobiology to society, advancement of science in Europe, environmental protection, as well as societal challenges from astrobiology, and potential conflicts of interest between astrobiology and commercial use of space will be introduced. Furthermore, the poster aims to point out to the timely role of an organised initiative in astrobiology education and popularisation of science.

## Acknowledgements

We would like to acknowledge the support of COST Action TD1308 ORIGINS, namely through the Short Term Scientific Mission (STSM) fundings: STSM- TD1308-010216-070847, STSM-TD1308-121216-081651, STSM-TD1308-1604180-40883 and STSM-TD1308-150418-040842. Further, the support of the Pufendorf Institute for Advanced Studies at Lund University, Sweden, through the 'A Plurality of Lives' research theme. The WP editors would also like to thank the authors and the international advisory board for contributing to this joint document.

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# Attitudes towards the scientific search for extra-terrestrial life among Swedish high school and university students

Erik Persson (1), Klara Anna Capova (2) and Yuan Li (1)
(1) Lund University, (2) Durham University, UK

(erik.persson@fil.lu.se)

## Abstract

The aim of the study was to increase our understanding of the attitudes towards the scientific search for extraterrestrial life among high school and university students in Sweden. The most important results of the analysis were that: (a) the great majority of students believe that extraterrestrial life exists; (b) most students regard searching for extraterrestrial life to be quite important or very important; (c) very few students think that we should actively avoid searching for extraterrestrial life; (d) the most common motive for assigning a high priority to search for extraterrestrial life is that it is interesting, the most common motive for assigning a low priority is that such knowledge would not be practically useful, or that the money would be better spent elsewhere; (e) most students do not think they are very well informed regarding the search for extraterrestrial life. A higher percentage of the students who judge themselves to be well informed also believe that extraterrestrial life exists. We have also found some differences between subgroups (men/women, high school students/university students and different fields of study), but the differences are with few exceptions small in comparison.

## 1. Introduction

The Washington charter for communicating astronomy with the public, formulated at the Conference on communicating astronomy with the public in 2003 states the importance of outreach and education efforts. It also urges the scientific community to actively participate in, and universities and other research institutions to provide institutional support for such efforts [1]. In order for education and outreach to be effective, whether we talk about astronomy, or as in this case astrobiology, it is important to have an understanding, not just of the level of knowledge of a given group but also of their general attitudes towards the discipline in question, its research questions and its basic concepts. This has implications for several areas such as funding allocation, the educational and professional recruitment base and science communication. In this study, we aim to present an indication of the attitudes among high school and university students in Sweden, towards what seems to be the most popular and inspiring part of the wider subject astrobiology, and even of modern space research in general, namely the scientific search for extraterrestrial life. To understand the attitudes towards a scientific field among students is important for several reasons. Firstly, it brings insights into how students perceive the field, its research questions, and the subject area in general. Secondly, it enables us to assess the level of interest in the discipline; and finally, it helps us understand how scientific enquiries shape public opinion and attitudes towards a given branch of knowledge. These are all aspects that affect, for example, the recruitment of future students. This, in turn, has a direct effect on university funding, either in the form of student tuitions, as is the case in many countries (including Sweden when it comes to non-EU students), or in the form of government money, which is partly based on the number of students. This type of knowledge is also important for research funding per se, since it indicates how researchers can justify their work to a wider audience. Finally, it can provide useful information for making decisions about how to design course components of school's science curriculum, as well as effective science communication and dissemination strategies

## Summary and Conclusions

A key finding of this study is that the majority (90%) of the 492 students responding to the question regarding belief in extraterrestrial life outside our planet believe that it exists. Another key finding is that a large proportion of respondents consider the search for extraterrestrial life to be quite important, and only very few students think it is something we should actively avoid. The most common reason for why students think we should search for extraterrestrial life is that it is interesting. The most

important reasons for why students think we should not search for extraterrestrial life is that such knowledge would not be practically useful or that the money would be better spent elsewhere. We have also found that most students do not see themselves as very well informed regarding the search for extraterrestrial life and those students who judge themselves to be well informed more often believe in the existence of extraterrestrial life. For further analysis, the students have been divided into subgroups according to their level of study, gender and major field of study. Some differences between subgroups (men/women, high school students/ university students and different fields of study) are identified, but the differences are typically small in comparison with the overall trends, and typically matters of degree rather than direction. One tendency that could still be detected was that differences we did find between fields of study were typically not so much between STEM and humanities/social sciences but more between the interest-driven artes disciplines (science and humanities) and the more applied disciplines (e.g. engineering and social sciences). The existence of a large gap between the positive interest among the students and how well informed they see themselves to be indicated that there is room for more science education programs and outreach activities aimed at students concerning questions related to the search for life beyond our planet. Some important conclusions were also reached regarding future research. We found a need to look more deeply into what kind of life students think of when asked about extraterrestrial life. We also found a need to follow up on why students believe in the existence of life outside our planet and to motivate their assessment of how long it will take before we find life outside our planet. In addition, we found a need to further investigate why different groups (men/women, high school/university students and majors of different fields) differ when it comes to how well informed they judge themselves to be regarding the scientific search for extraterrestrial life. A natural progression of this work, in addition to taking on the questions mentioned above, is to also target students in different countries and other groups than students. The insights about the students' perceptions of the importance of the search for extraterrestrial life gained from the study could be particularly useful in designing strategies for educating and recruiting students. In general, the results indicate that interest, usefulness and economy are areas that play a key role in students' attitudes regarding the importance of searching for extraterrestrial life. The focus on economy indicates that it might be important to explain how relatively little money is actually used in the search for extraterrestrial life. It has been shown that most Americans tend to overestimate NASA's share of the US national budget [2], [3]. We have no numbers regarding our respondents' estimation of how much money is spent on the search for extraterrestrial life, but it might be a reasonable assumption that it is skewed in the same direction. However, if the aim is to increase the funding, a better strategy has to be to produce good reasons for why money used for searching for extraterrestrial life is actually money well spent, which brings us back to the previous point about it being interesting and/or useful.

## Acknowledgements

The authors want to thank the very helpful staff at the Pufendorf Institute, and the Center of Theological Inquiry, all the teachers who helped us distribute and collect the questionnaires, and not least, all the students who completed the questionnaire.

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# How did life begin?
## A unique opportunity for science outreach in the context of the GENESIS-SKA project

**Alessandra Zanazzi** (1), Caterina Boccato (2), Ileana Chinnici (3), Serena Pastore (2), Francesca Bacciotti (1), Claudio Codella (1) and the SKA- GENESIS team

(1) INAF Osservatorio Astrofisico di Arcetri, Largo E. Fermi 5, 50125 Firenze Italy (zanazzi@arcetri.astro.it)
(2) INAF Osservatorio Astronomico di Padova, Vicolo dell'Osservatorio 5, 35122 Padova, Italy
(3) INAF Osservatorio Astronomico di Palermo, Piazza del Parlamento 1, 90134, Palermo, Italy

## Abstract

The GENESIS-SKA project (GEneral conNditions in Early planetary Systems for the rISe of life with SKA) is supported as a PRIN (Public Research Project of National Relevance) of Italian National Institute for Astrophysics (INAF) and its main goal is to study dust evolution, planet formation, and pre-biotic chemical complexity, in the context of preparation of SKA Key Programmes. The project also accounts for communication, public and industrial outreach of its scientific goals and results: this makes it one of the rare examples in which outreach and dissemination are professionally developed in the framework of a research project. GENESIS-SKA has a dedicate outreach work-package and a specific activities' plan which we would like to present and discuss with the scientific community. Exoplanets and the physical conditions for the emergence of life are strongly attractive topics for the public in general and we will leverage on them in order to create and promote our communication.

## 1. Introduction

The recipe to make a habitable planet like our own Earth requires a relatively small rocky planet, at the right distance from the host star, with a not too thick atmosphere rich in volatiles and capable of developing complex organic molecules chemistry. The GENESIS-SKA project, is carrying on studies of planet formation, and pre-biotic chemical complexity, in the context of preparation of SKA Key Programmes [1, 2]. GENESIS-SKA endorses a multi-wavelength approach to proto-planets formation (e.g., at infrared, optical, sub-mm, mm- and cm-wavelengths) and it will identify new scientific case studies to be deepened when the SKA telescopes will be operative.
The big question that the project would like to address is: What are the proper (physical, chemical, and dynamical) conditions – during the early formation phases of planetary systems – which can determine the rise of life?

## 2. The communication activities

It is quite clear that the GENESIS-SKA project scientific aspects are especially well suited for outreach, being related to the fundamental question of broad interest: How did life emerge?

In this context, the work will be done in synergy with the central INAF Communication Office as well as with the SKA Organisation (in particular the Cradle of Life working group), in order to communicate the motivations for building the SKA observatory and to promote broadly the INAF image focusing on its leading role on the SKA-related activities on the origins of life.

Regarding communication and outreach activities we have identified the following main goals:

1. dissemination of the main scientific aspects of this project to peers, creating a visual identity for posters and presentations and procedures for press releases and public communications;
2. dissemination of the main scientific aspects to the general public, through dedicated presentations, public talks, participations in science festivals and science events, realization of comics, production of original materials for exhibitions and public events. We will take advantage of previous professional engagement in other outreach

activities, in general, and, in particular, in the INAF supported GAPS (Global Architecture of Planetary Systems) observational project [3]; also, in order to better exploit our goals, we are setting up collaborations with other international projects aimed to communicate the scientific aspects related to stars and planets formation (e.g. using comics or cartoons [4]);

3. communication to students and schools, with education oriented presentations and educational materials and activities, tailored accordingly to the knowledge level of different targets;
4. strengthening of the relationship between INAF and national industries already involved in SKA and fostering business involvement and new collaborations with the entrepreneurial sector potentially interested in SKA. This will also be done participating in technological fairs and promoting an *Innovation day* and initiatives for industries interested in being involved in the development of technological projects)

An important issue in outreach is also the ability to trigger the *wow factor* in order to get the youngest interested and to leave them with the awe that will make them quest for more. SKA is a very big scientific and technological project, but it is not yet physically built: for this reason, we are studying the realization of a virtual reality exhibit, integrating the virtual rendering of the antennas array with virtual content.

# Acknowledgements

This work has been supported by the project PRIN-INAF 2016 The Cradle of Life - GENESIS-SKA (General conditions in Early Planetary Systems for the rise of life with SKA).

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[3] http://altrimondi.inaf.it/

[4] http://www.oact.inaf.it/exoit/EXO-IT/Projects/Entries/2011/12/27_GAPS.html

[5] https://www.costellazionemanga.eu/index_en.html

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# The planetary "Grand Tour" in the Czech Republic

**Tomas Petrasek** (1), Julie Nekola Novakova (2), Kosmo Klub, z. s.

(1) Faculty of Science, Charles University, Prague, Czech Republic, (2) Laboratory of Evolutionary Biology, Faculty of Science, Charles University, Prague, Czech Republic

## Abstract

Kosmo Klub is an association of space enthusiasts in the Czech Republic, dedicated to popularization of astronautics and space science since 2004. Its most recent project is the Planetary Trail in Prague. It is a model of the Solar System at 1:1 000 000 000 scale located along a frequented trail for cyclists and pedestrians along the Vltava River. It will provide the visitors with basic information about our cosmic neighborhood, and provide a base for further outreach activities.

## 1. Introduction

Blazing past the planets in the Solar System is a wonder for our imagination - and bringing the wonder of science to the general public is an important goal for both professional scientists and science popularizers. It educates and entertains at the same time, trains people in critical thinking, and explains the meaning and importance of scientific pursuit. Space sciences belong to the most exciting research fields - a source of fascination for children and adults alike. In the Czech Republic, astronomy outreach activities have quite a long tradition, with a network of public observatories and planetariums, several amateur associations, and many popular science journals and websites. Kosmo Klub is an association of space enthusiasts founded in 2004, which organizes regular public talks about space-related topics, and other activities. The most recent project is the Planetary Trail in Prague, which has opened this year. It is a model of the Solar System at 1:1 000 000 000 scale, featuring all the named bodies larger than 1000 km (34 bodies in total) - the Sun, planets, dwarf planets and large satellites - which are represented by stainless steel spheres. The model is stretched along a trail following the Vltava river, and the distance from the model Sun to the most distant object (Sedna) is 13,5 km. As both the sizes and distances are in the same scale, and most of the bodies are within a direct line of sight, it is possible to observe the correct apparent size of the model Sun (or moons etc.) from any planet up to Saturn. Every single body is accompanied by a label summarizing its important characteristics.

## 2. Figures

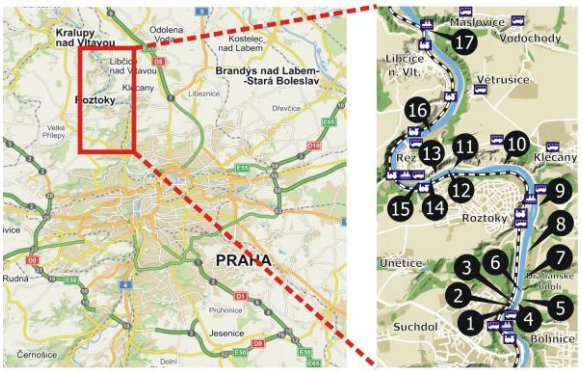


Figure 1: Map of the Planetary Trail. The major featured bodies include the Sun (1), Mercury (2), Venus (3), Earth and Moon (4), Mars (5), Ceres (6), Jupiter system (7), Saturn system (8), Uranus system (9), Neptune and Triton (10), Orcus (11), Pluto and Charon (12), Haumea (13), Quaoar (14), Makemake (15), Eris (16) and Sedna (17).

Figure 2: Newly finished model of the Sun and some of Kosmo Klub members who participated on its construction


Figure 3: The model of Mercury (the small sphere at the top) and its label

## 3. Summary and Conclusions

The Planetary Trail is perhaps one of the most detailed in the world, since it shows large moons as well as planets, and began to serve as a great practical tool for education. Programs for both adults and children are being developed, and we are planning commented walks in collaboration with other outreach organizations. Along with our other activities (teaching astrobiology, organizing popular science talks by guests scientists, collaborating on talks and workshops for pupils, etc.), it presents an opportunity to reach a wider audience and potentially also test the impact of the activities (like we did with our astrobiology seminar this spring, and could conclude that it helps the attendees learn).

## Acknowledgements

We would like to thank to all the Planetary Trail builders, especially Tomas Kocourek, who conceived the idea, chose the location and also played a major part in the construction, and to all the members of the participating associations Kosmo Klub and Hvezdolet. We would also like to thank the people and organizations who backed the project in crowdfunding campaign at Startovac.cz.

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# Europlanet Outreach Video - "Astrobiology: Life in the Universe"

**M. Barrosa (1,2)**, A. Heward (1, 2), on behalf of the Europlanet 2020-RI NA2 Outreach Team (1)
(1) Europlanet 2020 Research Infrastructure, (2) Science Office, Portugal
(mariana.barrosa@scienceoffice.org )

## Abstract

"Astrobiology: Life in the Universe" is the third educational video in a series of animations produced in the framework of Europlanet's 'Impact through Outreach and Engagement' work package with the aim of widening engagement with planetary science amongst Europe's citizens. It explores the use of analogue fields sites to study possible forms of life on other planets. To answer the question "Are we alone in the Universe?" the video shows how planetary scientists use the Earth as a laboratory to understand where life might arise on other planets and moons in our Solar System and beyond. The video highlights research linked to analogue field sites like Lake Tirez and Rio Tinto in Spain, and the Danakil depression in Ethiopia, where Europlanet offers access to planetary scientists and astrobiologists to visit and carry out experiments.

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# Lessons learned from using Socratic Dialogue in astrobiology education

**Erik Persson**
Lund University, Sweden (erikperssonsmail@gmail.com)

## Abstract

Socrates was not just a pioneer in philosophy. He was also a pioneer in education through his method of involving his interlocutors in the philosophical process. The method is often referred to as the majeutic method because according to Socrates, he helped the person he talked with to "give birth" to their own ideas just like a midwife helps other women giving birth to their children [1]. When the term 'Socratic method' is mentioned in relation to teaching it often refers to the method of asking questions. This is, however, not what I will talk about here. Instead I will talk about a specific formalized method for definition or analysis of a concept by a group according to a set of strict rules.

## 1. Introduction

For the past five years I have used the Socratic Dialogue to let astrobiology students make their own attempts at defining 'life'. 'Life' is a key concept in astrobiology but there is no consensus about how to define it. It is therefore perfect for this exercise. I will present both how I go about performing the dialogue and my experiences of using it.

## 2. The Dialogue

The version of the dialogue I have found works best proceeds in five steps:

Step 1. Concrete examples. The students start by providing examples of life.

Step 2. Choosing the best example. Here the stu-dents discuss the examples from step 1 and chose the example they think is the most fruitful for the con-tinuous discussion.

Step 3. Identifying why the chosen example is an example of life.

Step 4. Tentative definitions. Based on the previ-ous discussions it is time to start suggesting tenta-tive definitions.

Step 5. Iterative discussion. In this step the stu-dents discuss the pros and cons of the tentative defi-nitions from step 4 one by one and suggest new definitions. This step continues until consensus is reached or the time is up.

## 3. Summary and Conclusions

Learning about a concept by taking part in the definition process is much more fulfilling than just having the definition explained by someone else. It is more inspiring and it also leaves a more deep and lasting effect on the students' understanding of the concept.

This does, according to my experience, not just mean that the students will remember the definition or definitions they have been part of producing in the Socratic Dialogue. When the teacher later goes through the standard definition or the different uses of the concept in the course literature, the students will quickly be able to set it/them in relation to their own discussion and remember and understand it/them better than they otherwise would.

The discussions are always impressive, both to me and to the students themselves. That the students tend to get impressed by their own results is, I believe, beneficial both for their self-confidence and for the teaching.

One possible drawback is that the method is relatively time consuming. I have found, however, that it is possible to have a constructive dialogue over two hours. If it is possible to dedicate more than two hours it is even better. Less than two hours is not constructive.

The group size is also important. It is not meaningful to perform the Dialogue in very large groups. Ideally, the number of students should be around ten but between five and twenty works OK.

The primary benefits of the method can be summed up in the word 'transparency'. The method itself is transparent. It is easy for the students to follow the process and to appreciate their own progress. The

dialogue also helps to make concepts transparent. Concepts that to begin with appear as either murky and impenetrable or intuitively basic and therefore un-analyzable, can in a few simple steps be objects of a discussion on a high level of sophistication and become an integrated part of the students' understanding of the subject.

Another big advantage I have noticed with the Socratic Dialogue, is that the discussion often continues in the corridors or on the course website long after the exercise has finished.

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# Teaching Astrobiology in the modern classroom: a contemporary challenge and an opportunity for educators

**Margarita Metaxa**

(1) Philekpaideutiki Etaireia, Attiki, Greece (marmetaxa@gmail.com)

## Abstract

Astrobiology is an incredibly dynamic and engaging multidisciplinary topic that attracts professional scientists and amateur enthusiasts alike and can be used as a vehicle that provides a unique environment for educators from Kindergarten to Lyceum, for an introduction to science education.

We believe that by developing and promoting the teaching of Astrobiology in the broadest possible way to students we can introduce them to science in a very pleasant way and easily prepare them for a "life– long learning" journey. Furthermore, the cultural and philosophical role of Astrobiology is undisputed. Studying and sharing the exciting discoveries and unique perspective of astrobiology with a wider audience is a way of searching for our own origin, learning to situate ourselves within cosmic infinity and developing a sense for the beauty and fragility of our planet the Earth. It also allows us to keep a critical approach towards irrational pseudo-sciences.

We will present a role model of educational programs which has already been implemented in various successful Astronomy projects. As well we will present our future plans.