Junior Science Cafe Implementation Scenario: "Ask a scientist all you want to know about evolution!"

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Title of the educational scenario: Junior Science Café, Ask a scientist all you want to know about evolution!

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1: Introduction

This Implementation Scenario is designed as an 11-week (1 teaching hour per week) project. Ideally the actual event should have duration of around 2 hours, so three teaching hours could be merged for the day of the event. Merging three 45 minute teaching slots would give a total of 2 hours and 15 minutes. 5 minutes can be given at the beginning of the event for everything to be settled, the scientist presented and opening questions be asked. It is advisable to have a 10-minute break during the event.

2: Educational Challenges

The following Educational Challenges are observed. Reasons for implementing a Junior Science café as a response to these challenges are provided.

2.1 Understanding the common ancestry of all living things and the mechanisms of evolution

Although, the theory of Evolution was formulated by Charles Darwin more than 150 years ago, many people still find it hard to believe that 'man evolved from the ape' or to be more precise that they shared a common ancestor. Both fossil and molecular indicators strongly support this claim. Potential topics that pupils could investigate are how fossil findings support the theory of evolution as well as what living things have in common on a molecular, biochemical and even physiological level (for example embryonic developmental stages, common proteins).

While teaching the theory of evolution as part of the Greek curriculum for Biology (Chapter 7 of textbook for the 3rd year of Secondary School-Gymnasio), it was observed that many pupils were confused by the timescale evolutionary mechanisms take place in and what that means for real-life situations. This is possibly the case because if pupils consider their own lifetime they cannot perceive evolution, and instead should be encouraged to understand the scale of geological time. Only then can the impact of evolution be seen.

An example of fast-paced ongoing evolution is that of insecticide resistance. The pupils will be encouraged to research the topic and explain why this happens. Another way to illustrate how evolution functions on a shorter timescale is to ask pupils to look into artificial selection by which humans have been selectively breeding plants and animals to get offspring with desirable traits.

In addition, pupils found it hard to grasp that evolution is an ongoing procedure that is still happening (page 132, paragraph 2). It would be challenging to ask pupils to imagine how evolution will impact on humans and other organisms, how will their future versions look like and why. They could also be encouraged to collect material from literature and film and discuss how others have imagined the future of life on our planet.

A further interesting point that can be stressed is that of speciation, the creation of new species (page 133, paragraph 1) in contrast to extinction. Most pupils are aware of cases of extinction such as the dinosaurs and the mammoth, but they could be given the opportunity to explore the topic to a deeper level and look into the birth of new species as well.

Reasoning for choice of approach:

The approach is more direct and interactive than the school textbook, as pupils must directly engage with the material and acquire knowledge through their own investigation. After they have collected what they consider to be relevant material, they will have to present their topic illustrated by examples. They will be encouraged to use computers for PowerPoint presentations that could include videos and animations. They will also have the opportunity to engage with an active researcher and clarify any points that have emerged out of their own investigation.

2.2 Cooperation and inclusiveness

In a time when racial discrimination and bullying are on the rise, principles of evolution can be utilized to show pupils that there is no scale of superior and inferior beings and that every living thing has evolved the way it has only for one reason: to survive. In this way pupils will be encouraged to avoid discriminations and treat each other as equal. Apart from this, we live in a time when communication is transforming rapidly and the young are increasingly using technology to communicate. The pupils will be encouraged to understand how essential communication has been to our very existence.

Evolution functions through natural selection on the basis of what makes an organism better equipped to survive in a specific environment under specific circumstances (page 132, paragraph 3). A good example to demonstrate this point is to encourage pupils to look into how the human race evolved different characters such as skin color.

Learning about the evolution of the human race (page 136, paragraph 4) pupils will be asked to research the importance of communication and knowledge transfer. The topic could be expanded to include communication in other organisms or the evolution of human communication and how technology has changed it.

Reasoning for choice of approach:

Through the Science Café pupils will not only learn in theory about the science behind different traits and the importance of communication, but will also get to work collaboratively in groups to achieve common goals (researching a topic, preparing a presentation, organizing an event, reporting on the experience). This will potentially help them overcome any discriminating or bullying attitudes and will give them the chance to physically communicate while also employing technological tools.

2.3 Considering a career in science

Many governments are concerned that not enough young people are attracted to STEM (Science, Technology, Engineering, Mathematics) careers. In addition to this, there are concerns that specific groups (females, ethnic minorities) are underrepresented in the world of scientific research. The 2013 ASPIRES survey funded by the UK's ESRC with a focus on the career aspirations of 10-14 year olds showed that although all children have high aspirations, the fields that are the most popular are business and art & design, whereas science falls far behind. It seems that many students have a positive view of science and scientists but do not however consider it as something they could practice themselves. The study concluded that the main factors that influence pupils' aspirations towards science are their families' "science capital" (how close they are to science overall, if they have scientist acquaintances etc.) and unawareness of the career options science can offer. In addition to this, pupils seem to be held back by their perception of science being only for "brainy" people, and mostly white males.

Reasoning for choice of approach:

Pupils will have the chance to speak to research practitioners and ask them about their career and work life. Humanizing the scientist is of great importance for pupils to understand that anyone can do science and it's not only geniuses locked in labs who do it. It would be especially encouraging to invite female researchers to help break the stereotype of the male, middle-aged scientist, and show girls that science is as much a prospect for them as it is for boys.

3: Scenario Characteristics and Needs of Students

The scenario will be an opportunity for students to explore issues related to the theory of Evolution. **Although it requires some existing knowledge of the principles of evolution, covered in the textbook, it will give pupils the opportunity to deepen their knowledge and focus on issues of their interest.** They will also **have the chance to get first-hand information from an active researcher in the field and also get familiar with what it's like to be a scientist**. This could potentially have an impact on the career choice of some pupils.

The approach is more direct than school textbooks, as pupils must directly engage with the material, acquire knowledge, present to classmates, organize an event, interact with a scientist and reflect upon the whole procedure.

The exercise will also **allow students to interact by working in groups and develop social and collaboration skills**, thus experiencing how scientific inquiry can be a group activity and not only a solitary one.

Pupils will improve their presentation skills with constructive feedback by their teacher and classmates. They will also be encouraged to use computers and the internet to find engaging and fun ways to present their material such as videos and animations.

4: Rationale of the Educational Approach

At the initial question eliciting stage of the project teachers are encouraged to use diagrams, images, videos and concept maps to attract the pupils' interest. An example of material to be used follows:

Image 1	Image 2

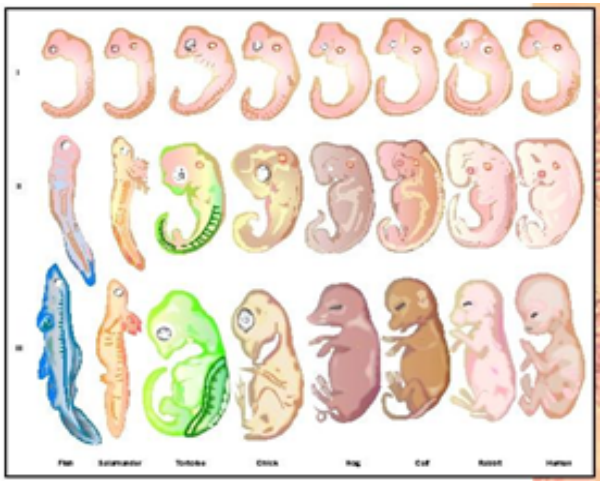
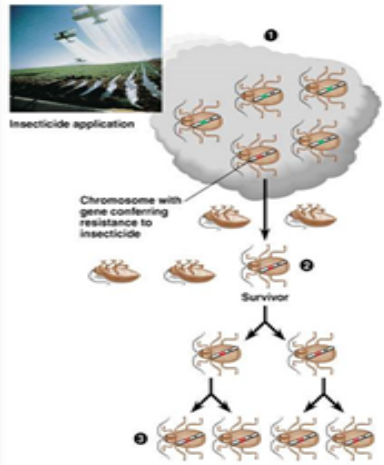

	

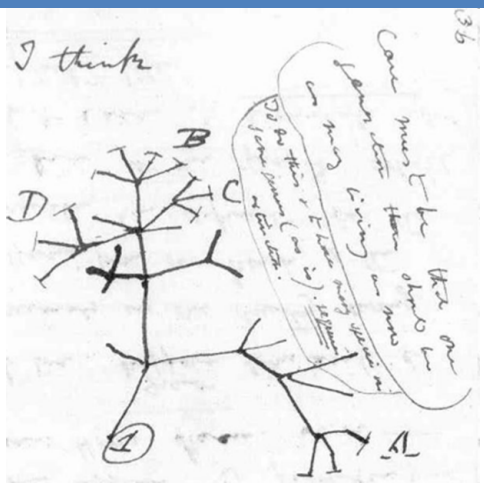
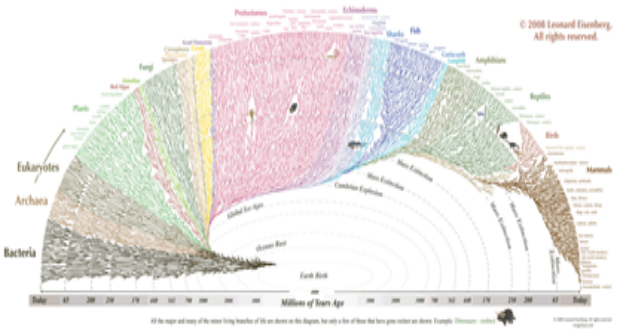
Image 3	**Image 4**
	

Image 1 demonstrates the similarities between embryos of different species. A sample question that could stem from this image could be "What signals the differentiation of organisms while they are growing embryos, at which time point does this happen and why?".

Image 2 demonstrates how insects develop resistance to insecticides with natural selection in action. A sample question that could stem from this image could be "How did the surviving insect acquire the resistance gene?".

Image 3 is a sketch by Darwin himself showing the initial conception of the notion of all living things having a common ancestor and evolving in a tree-like manner. In **image 4** the pupils can see how far scientists have come starting from Darwin's simple tree to an ever growing tree of life, based on both morphological and most recently molecular data on the evolutionary relations of all living things. A sample question that could stem from this image could be "What was the role of mass extinctions in the evolution of life? Did they slow it down or speed it up?".

The Rap Guide to Evolution is also an enlightening and amusing project that possibly the pupils will be more able to connect and engage with. Find it here http://rapguidetoevolution.co.uk/ .

5: Learning activities

The CREAT-IT activities are conceptualized as Inquiry-Based Science Education (IBSE) activities. This is structured around the five IBSE phases suggested by the Cosmos project (2008):

Phase 1: Question Eliciting Activities/Exhibiting Curiosity
Phase 2: Active Investigation
Phase 3: Creation
Phase 4: Discussion
Phase 5: Reflection

In the following table, specific Junior Science café activities are based on an understanding of IBSE, including both teachers' and pupils' inquiry processes, based on the CREAT-IT Pedagogical Framework.

Science unit topic: Biology **(Greek Secondary School curriculum)** Class information Year Group: 3rd grade Age range: 13-14 y.o. Sex: both Pupil Ability: -	**Materials and Resources** *What do you need?* A microphone for the invited speaker. A camera to film the event and post-event interviews. Printed questionnaires. *Where will the learning take place? On site or off site? In several spaces? (e.g. science laboratory, drama space etc), or one?* The preparatory activities will take place in the classroom and during the pupils' own study time. The actual event will take place in a large classroom or school theater so other pupils outside the project can also attend. *Health and Safety implications?* None *Technology?* Computer with internet access. *Teacher support?* None

Prior pupil knowledge

Pupils will have learnt about the meaning of species and populations (Chapter 1). Pupils will be aware of basic principles of evolutionary theory and the evolution of mankind (Chapter 7).

Individual session project objectives *(What do you want pupils to know and understand by the end of the lesson?)*

During this scenario, students will

Weeks 1-2: Be attracted to engage with topics of evolution. Ideally they should feel challenged by questions about the evolution and biodiversity of life.

Week 3: Be familiar with the concept of a Junior Science Café.

Weeks 4-8: Have a deeper understanding of the topics examined and come up with further questions. In specific, be aware of the data that support the theory of evolution, understand how evolution functions through natural selection based on the variability and adaptability of organisms, as well as the timescale. Be able to explain how species are born and become extinct. Perceive human communication as a beneficial trait for the evolution of the species.

Week 9: By asking the scientist questions and actively engaging they will acquire a deeper understanding of the topics and come up with further questions. They will also be more aware of what it's like to work as a scientist.

Week 10: Think of how they would improve the event.

Week 11: Know how to upload material (project outcomes) on the web.

Assessment Pupils will be asked to write group reports on how the event helped them understand their topics and the theory of evolution in general. They will also be given a questionnaire to be filled in individually in class. This questionnaire will include questions about their level of enjoyment, level of difficulty and comparisons to more traditional teaching methods.	**Differentiation** *How can the activities be adapted to the needs of individual pupils?* The project provides a variety of opportunities for each pupil to practice their own talents. All of the students will be required to participate in the investigation phase equally. However, they can be involved in varying degrees in the organizational aspects for the event, the interaction with the scientist, the social media coverage, the post-event interviews, article writing for the school newspaper and final report writing.	**Key Concepts and Terminology** **Science terminology:** Natural selection, trait, variability, adaptability, speciation, extinction, geological time, artificial selection, human evolution, fossils **Arts terminology:**

CreatIT	**Implementing Creative Strategies Into Science Teaching (CREAT-IT)** **Implementation Scenario**

Session Objectives:
During this scenario, students will

- Prepare for and organize a Junior Science Café event, while using tools of inquiry-based learning.
- Deepen their understanding of the theory of evolution.

IBSE Activity	Potential arts activity	Student	Teacher	12 CREAT-IT Pedagogical Principles
Phase 1: Question Eliciting Activities Weeks 1-2 (1 teaching hour per week) (1-2 hours individual homework to respond to challenges)		Engage with teacher's questions. Watch videos and use the web to explore evolution.	Will use challenging questions and the web (images, videos) to attract the students' interest in the theory of evolution. Could give challenges to students in Week 1 to be answered and discussed in Week 2 (e.g. giraffe's long neck, Darwin's finches etc). At the end of week 2 they will announce to the students the Science Café project and ask them to note down anything they find exciting, inspiring or challenging about evolution.	*Highlight the principles relevant to the lesson* 1. *Individual, collaborative and communal activities for change* 2. *Risk, immersion and play* 3. *Dialogue* 4. *Interrelationship of different ways of thinking around a shared 'thread' or 'throughline'* 5. *Discipline knowledge* 6. *Possibilities* 7. *Ethics and trusteeship* 8. *Empowerment and agency*
Phase 2: Active Investigation Weeks 3-8 (1 teaching hour per week) (5 hours group homework to collect material) (2 hours group homework to prepare presentations)		Will be expected to contribute in the research of their group's topic and prepare a presentation of the findings. Will be encouraged to include engaging aspects in their presentations such as videos and animations from the web. They will also be asked to find local researchers in the field.	In Week 3 the teacher will ask the pupils to split in groups of four and will give them a choice of different evolutionary topics for each group. Some of these could include fossils, common traits of living things, artificial selection, the future of evolution, human skin color, speciation and extinction, the impact of communication on human evolution, insecticide resistance: evolution in fast-forward. The teacher can suggest sources (both printed and online) where the pupils will find relevant information. During the presentations the teacher will promote discussion and deeper understanding by posing relevant questions.	

Phase 3: Creation Weeks 4-8 (1 teaching hour per week)		Students will collect questions emerging out of their research. It is advised for each group to collect four questions and rate them according to importance. One pupil from each group will commit to making the list and asking the questions during the event. One pupil will commit to contacting potential scientists and getting the headmaster's permission to use the room. One student will commit to facilitating the event.	The teacher will overlook the question-choosing procedure and provide further advice if needed. They will also be available to help students contacting experts, booking a space etc.	
Phase 4: Discussion Week 9 (3 teaching hours)		One student from each group will pose the set questions to the scientist in an order of importance. It will be the facilitator's responsibility to ensure questions from all groups are asked. They could keep track be having a list of all questions per group and ruling them out. All pupils will be encouraged to ask any other questions that come to mind and engage in a discussion with the scientist, especially in matters concerning the nature of their work, their career route and their	Overlook the event, film it and intervene only if required. Upload the video of the event on the school's YouTube page.	

		everyday work activities. One student from each group will tweet about exciting things that emerge during the event. One pupil will interview the scientist, pupils who participated in the project as well as other pupils who only attended the event. The interviews will be filmed by another pupil.		
Phase 5: Reflection Week s 10-11 (1 teaching hour per week) (2 hours group homework for report writing) (1-2 hours individual homework for the pupils that will write the articles)		On Week 10 they will discuss event and suggestions for improvement (Week 10). They will be given evaluation questionnaires to fill in in class. One pupil from each group will write a short article for the school newspaper. One pupil from each group will write the report after consulting with their fellow group members and re-watching the filmed event if necessary. On Week 11 they will hand in the report and articles and upload project materials (filmed interviews, reports, articles) on the web (school website, FB page, CREATIT portal).	On Week 10 they will discuss the event in class, give out and collect questionnaires and instruct the groups to write reports until the following week. The reports will require discussing the pupils' experience in terms of the scientific discipline (what they learnt, further questions). They will also instruct one pupil from each group to write by the following week a short article about the science café that will be published in the school newspaper and online. On Week 11 they will help the pupils upload project material on the web.	

6: Performing the Junior Science Café – Additional Information

6.1 Students

For a class of 20 pupils it is recommended to divide them in 5 groups of 4 pupils each. Each group will choose to research a specific topic. The number of groups is flexible according to class size; however the group size is advised to be kept to 4 pupils in accordance to the distribution of responsibilities. Each one of the four pupils in a group will be given one responsibility (asking the questions to the scientist, twitter coverage, report writing and article writing). There are other actions that need individual commitment (contacting the scientists, booking the venue, facilitating the discussion, interviewing post-event, filming the interviews) and can be freely selected by pupils, provided their roles don't clash (e.g. asking questions and facilitating the event). Students from the same year or older can also attend and participate in the discussion encouraged and supported by the teacher and event facilitator.

6.2 Project instructors

Some suggested sources for information on Evolution are:

Websites

http://www.nationalgeographic.gr/ , http://www.nationalgeographic.com/

http://www.scienceillustrated.gr/site/

http://sciencefocus.com/home

Videos and documentaries

https://www.youtube.com/watch?v=w_-y65DXw0g

http://www.hprt-archives.gr/V3/public/main/page-assetview.aspx?tid=26851&autostart=0

http://greek-documentaries.blogspot.gr/2012/08/hd-discovery.html

http://greek-documentaries.blogspot.gr/2013/01/becoming-human.html

http://greek-documentaries.blogspot.gr/2012/05/bbc_19.html

Literature

http://www2.biology.uoc.gr/courses/BIO102_zoologia/For%20website/02%20Lecture.pdf

Πασκάλ Πικ, "Εξηγώντας στα παιδιά τη θεωρία της εξέλιξης. Ο Δαρβίνος με απλά λόγια", Μετάφραση: Αριστέα Κομνηνέλλη, Μεταίχμιο, 2009

Douglas Palmer, Peter Barrett "Εξέλιξη: Μια ιστορία ζωής 4 δισεκατομμυρίων ετών", Σκάι

Dylan Evans, "Εξέλιξη: Εικονογραφημένος οδηγός", Δημοσιογραφικός Οργανισμός Λαμπράκη