D3.1.1 Student Parliaments

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1 Introduction / Demonstrator Identity

1.1 Subject Domain

Biology, Engineering, Technology (The Future of the Human Being)

1.2 Type of Activity

The specific activity is a combination of:

(a) School based and

(b) school – research centre collaboration

As it is developed the activity can be characterised as a Large scale Activity at a National level

1.3 Duration

Approximately 5 months

1.4 Setting (formal / informal learning)

Both formal and informal. The setting involves classroom discussion and activities and visits to research centers and contact with relevant scientists both in presence and online.

Formal and Informal learning settings

- Classroom
- Venue for final debate event
- Research center (physical visit or virtual)
- Open Discovery Space portal (http://www.opendiscoveryspace.eu/community/greek-student-parliament-science-834221 - as a collaboration area)
- Activity's Website (http://studentparliament.weebly.com/ - for information, instructions etc.)
- The Adobe Connect platform for the communication of participants as well as the implementation of the final event (http://connect.ea.gr/studentparliament/). It allows connection with remote and/or rural schools.

1.5 Effective Learning Environment

- Communities of practice (web-based/physical)
- Dialogic space / argumentation
- Visits to research centres (virtual/physical)
- Communication of scientific ideas to audience

2 Rational of the Activity / Educational Approach

2.1 Challenge

Although argumentation consists a core feature that accommodates the epistemology of science, science education has failed to incorporate it in its didactics (Smyrnaiou, et al., 2015). The same way argument and critique are essential skills in the scientific community for the delivery of its main objectives – production of new knowledge and reinforcement and validation of ideas (Osborne, 2010) – argumentation as an educational technique in science classes has been found to be tightly related to students' acquisition of scientific knowledge and enhancement in acquiring higher order skills related to problem-solving, scientific reasoning, communication capabilities and analytical thinking (Sandoval, 2003; Schwarz, et al., 2003).

By excluding the element of argumentation –as a "dialectical approach" -from the learning process of the science classes, we fail to instill in students the challenging aspect of scientific inquiry (Kuhn, 2005) and to enable them to develop a holistic view of the required process for the production of scientific knowledge and scientific discourse. Students deprived of this scientific procedure, either verbally by the lack of argumentation language or practically by the absence of inquiry practices, perceive science as a ready to consume product and an authoritative and sterile field that allows for no challenging exploration. The reason of deprivation of science education from argumentation and debate educational practices lies in the one-dimensional delivery of science instruction, strongly focusing on the transmission of knowledge rather than on the individual engagement in the process of understanding and perceiving the way we came to acquire this knowledge; a fact that is also emphasized by the curricula and the authorized educational material that support science teaching (Smyrnaiou, et al., 2015).

As a result, students fail to face and clear up the misconceptions they have on scientific issues and concepts since ready-made and indisputable explanations offered by their teachers leave no room for scientific reasoning and construction of scientific knowledge based on the ground premises of mental exploration, testing hypotheses, data collection and consequent discursive exploration. It is through the students' effort to make their claims comprehensible and sound while addressing others that engages them in deep rationalization and construction of solid knowledge (Jiménez-Aleixandre & Pereiro Muñoz, 2005; Sandoval & Reiser, 2004). However, learning derives as the product of the cognitive interaction and conflict between intuitive learning and new cognitive schemas and ideas that are structured by challenging our intuitions while engaged in situations in which we must provide data and arguments in order to support and strengthen our claims (Smyrnaiou, & Evripidou, 2012). Students engaged in argumentative interactions will be required to step back from their claims, examine their proposals with respect to counter-arguments, reflect on their current domain knowledge or submerging experimentation evidence and come up with new ideas that will be inner-examined in terms of scientific accuracy and validity (Erduran, 2014; Jiménez-Aleixandre & Pereiro Muñoz, 2005). Debates and collaborative discourse are valuable learning situations that enable students to undergo such a mental inquiry process where misconceptions can be tested and eliminated and suggestions and/or counter arguments by others facilitate the up-springing of new ideas, trigger more advanced claims and enhance individual engagement in the connection of claims with data (Jiménez-Aleixandre & Pereiro Muñoz, 2005; Sandoval & Reiser, 2004).

2.2 Added Value

The Student Parliament demonstrator is grounded on the Collaborative learning and Inquiry –based scientific approach in the form of argumentative discourse produced in collaborative problem-solving situations as an empowering interactive learning mechanism in which students engage cognitively in potential conceptual transformations and 'constructive interactions' (Smyrnaiou, et al., 2015). Students are engaged in a joint attempt of mutual understanding through argumentation interactions (Smyrnaiou, & Evripidou, 2012) which act as filters of intuitions and misconceptions (Osborne, 2010). Students participating in these communicative interactions become committed and are driven by the main objective to appear reasonable –in alignment to background/reference knowledge on scientific domain and application of relative discourse and subsequent norms. By having students work in collectives to prepare for a debate process against other teams, engaged in a search of providing strong and rational-based claims, the scope of the communicative interactions becomes wider, involving persuasion, convincing, problem-solving and engagement in an in-depth knowledge co-construction process (Jiménez-Aleixandre & Pereiro Muñoz, 2005).

In addition, students are given the opportunity to experience the challenging aspect of scientific inquiry and become engaged in the negotiation of authentic scientific issues/problems by providing and sharing multiple alternative perspectives for their solution. This way creativity and alternative thinking is instilled in students who are enhanced to come up with their own solutions to contemporary problems and challenges that need to be solved. Furthermore, the student-scientist exchange approach (directly communicate with scientists as well as visits to research centers) provides a challenging learning setting, rich in authentic information on current issues in science and research. Besides the context of the learning environment, a key aspect for the full realization of the Student Parliament demonstrator is the content of the activity that is defined by considering students' personal needs and interests in order to enhance students' mental engagement in the learning process. The future of the human being as a generic topic is challenging and relevant to students lives and allows plenty of room for differentiated exploration and approach guided by students own needs and interests. The specific topic involves issues on exploiting scientific and technological findings towards shaping a bright and sustainable future for the generations to come; issues more relevant nowadays than ever before and directly affecting youngsters' lives. In addition, this generic topic that invites for inquiry on the issue of the future of humanity has been subject of speculations and science through all times and most of all through different disciplines. Therefore, students will have to inquire and debate on a multidisciplinary and multi-dimensional issue applying their problem solving, critical and analytical skills and reflect and provide arguments for relevant bioethical issued that will arise.

3 Learning Objectives

3.1 Domain specific objectives

The main aim of the SP approach is to **improve pupils' enjoyment of and attainment in science via open-ended investigations**. Also, to give students opportunities to explore possible answers to scientific questions which are related to real life via practical and inquiry-based experimentation. This is achieved through providing opportunities for students to discuss key scientific concepts and processes with experts in the field. The

The SP's domain specific objectives are to:

- Get students interested in science and research through the parliamentary procedure
- Teach students how to form a qualified judgement and assess complex topics
- Initiate an objective discussion, particularly about controversial topics
- Initiate contact between students and scientists (particularly young scientists)
- Inform students about topics on a European or International scale
- Inform scientists about the views and new ideas of young people
- Build National-wide student networks

Towards attaining these objectives, peripheral aims are formed addressing students' needs to:

- develop abilities necessary to do scientific inquiry
- develop understandings about scientific inquiry
- identify questions and concepts that guide scientific investigations
- design and conduct scientific investigations
- use technology to improve Investigations and communications
- formulate and revise scientific explanations and models using logic and evidence
- recognize and analyze alternative explanations and models
- communicate and defend a scientific argument
- develop lifelong learning skills
- develop attitudes befitting a scientific ethos
- link with science and society in a personal context

3.2 General skills objectives

In the context of the SP, students' general skills objectives are:

- Active participation and engagement in the negotiation of scientific concepts
- Developing creative and critical skills
- Understanding and applying the scientific inquiry approach (inquiring and developing arguments based on evidence)
- Connecting science with aspects of their everyday life

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- Interacting with experts and experiencing at first hand scientific approach/attitude (demonstrating effective community building between researchers, teachers and students)
- Developing spirit of cooperation and teamwork
- Acquiring lifelong learning skills

4 Demonstrator characteristics and Needs of Students

4.1 Aim of the demonstrator

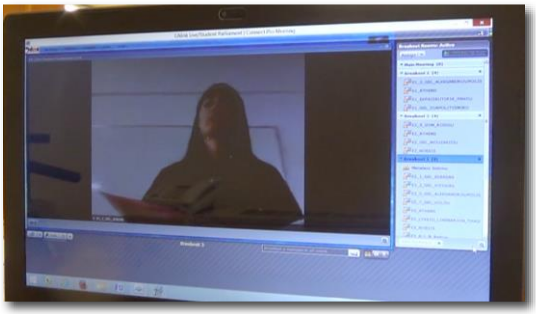
The demonstrator's main aim is "to strengthen the dialogue and exchange of ideas between students and scientists, introduce students to parliamentary procedures on science and research, enabling students to form a qualified opinion and to assess complex topics, and introduce students to a scientific community" by inquiring and processing information on current issues in science and research.

The SP's main topic for negotiations is 'The future of the human being' further categorized in five sub-topics:

1) The Human Brain,
2) Living and eating healthy – but how?,
3) Stem cells – the potential allrounders?,
4) Augmented human: optimising the human and
5) Imitating nature.

In the activity participated 50 school teams from both public and private schools. The project is addressed at students between 16 and 19 years old in levels 10 to 12 with interest in the functioning of democratic systems, with interest in science and in learning about new topics, with ambitions to share their ideas in discussion. By immersing learners in active investigations of contemporary issues, and engaging them in collaborative discourse, they manage to constructively build on each other's ideas and enhance their learning of scientific concepts.

This Initiative is designed as an approximately 5-month project. School groups will be expected to spend at least 2 hours per week to explore and inquire the scientific issues under negotiation, communicate their ideas with scientific experts and prepare a set of arguments for the final debate event. However, inquiry and communication of scientific ideas or queries is also held through the communication forum of Open Discovery Space and also as a main tool for live communication is the Adobe Connect platform where a specific meeting place developed.



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Students are free to present evidence or realization of their claims through creative, alternative and innovative approaches.

4.2 Student needs addressed

In the SP the topics for negotiation were selected due to their challenging factor and their centrality to contemporary scientific issues and problems that need solving. It was identified that by immersing learners in active investigations of contemporary issues, and engaging them in collaborative discourse, they manage to constructively build on each other's ideas and enhance their learning of scientific concepts. Having students motivated by and engaged in authentic problems that require solving and stimulate their creativity and critical thinking they become key players of the learning process. Students are highly engaged in applying creative solutions while dealing with topics which are critical for their own lives and surface the essential relevance and connection between the curriculum and their everyday life or future career (Johnson, et al., 2009). In this highly motivating and challenging process, students acts as scientists and naturally apply inquiry–based approaches to address the problem under negotiation. They develop research questions, identify, investigate and experiment on various solutions with the help of primary source materials and construct knowledge and build their argumentation discourse in their effort to identify the most efficient and reasonable solution in terms of applicability. The guidance provided by scientific experts not only manages to relate the scientific research with educational environments but also to ensure a high-quality production of findings and to give the process relevance to authentic scientist way of working.

SP aims at strengthening the dialogue between students and science, by engaging students in problem-solving situations involving scientific issues that address current problems. In the simulated parliaments, the participating students become acquainted with parliamentary decision-making processes as well as scientific research grounded on the model of Inquiry-based learning and develop life-long and communicative skills by engaging in dialogue and debate processes aiming at the exchange and sharing of scientific points of view.

During the plenary debate students are given the opportunity to discuss the different sub-topics and exchange their knowledge with the other students in order to collaboratively come up with some final resolutions that will be developed based on their scientific inquiry, evidence gathered and in strong relation to their personal beliefs and attitudes regarding ethical concerns on the 'future of human beings'.

Exemplary Debate Resolutions

In this section, there are presented some possible resolutions for each one of the 5 sub-topics that concern the issue of the 'Future of the human beings' in the form of final points assessed by students and final claims.

- For the sub-topic **'The Human Brain'** students could discuss and assess aspects and problems related to therapies against dementia illnesses and current research and findings on the way the brain works. Some possible resolutions for this sub-topic are:

  Points assessed:

  1. The human brain functionality/generic factors accused for Alzheimer disease
  2. Social/economic/scientific aspect of Alzheimer disease
  3. Legislation concerning patients
  4. Research and /funding /bioethic
  5. Non- invasive methods (electro-egephalograph (EEG), fMRI, PET)
  6. Invasive methods e.g. medication
  7. Prevention
  8. Brain simulation

  Final claims:

  1. Contribute to an action plan comprising the establishment of special centers in charge of prevention and treatment/health care/ mandatory mental examination for high-risk groups
  2. Exploitation of stem cell
  3. Use artificial intelligence to identify innovative remedies
  4. Create a global database with bio signal (EEG, fMRI) for research purposes

- For the sub-topic **"Living and eating healthy – but how?"** students could elaborate and inquiry aspects of organic food, genetically engineered foods and their impact on our health and identify conditions and criteria for eating healthy. Some possible resolutions for this sub-topic are:

  Points assessed:

  1. The Mediterranean diet is very healthy because it is low in fats and calories and contributes to the reduction on heart attacks, cancer and Alzheimer.
  2. We should not consume enriched in ingredients food types, such as food full of salt, but we should consume superfoods, such as beans, broccoli and ginger.
  3. We should consume vegetables, fruits and pulses because they reduce cancer and heart diseases.
  4. We should avoid genetically modified food since we are not sure of its usefulness. Moreover, genetically modified food is not environmentally friendly as it damages the ecosystem by changing the life chain, and the cost of the cultivation is high.
  5. We should avoid the consumption of sweets because they are full of sugar and fats and they can cause obesity and diabetes.
  6. There must be strict laws which will define the harmful ingredients of the food types and also, labels of the ingredients of the food products should be on their package.
  7. Being vegetarians is not healthy because human organism cannot take all the vitamins and proteins needed. Consuming meat is also useful but in small quantities.
  8. Organic food is high in vitamins and low in fats, calories and fertilizers. But it is expensive and consumers cannot afford it. Governments should contribute to the cultivation of it by eliminating taxes.

Final claims:

1. We should be conscientious consumers and we should be informed about the dangers of various food types and the benefits of various foods / we should examine the food labels.
2. We should choose products which are environmentally friendly for sustainable development, giving emphasis on food types which have vegetable origins, local products, traditional products and food types which are coming from organic production.
3. We should follow a combination of a balanced diet (Mediterranean diet) accompanied with physical exercise and adequate hydration putting emphasis on water and beverages, and we should be aware of our diet.
4. A conscientious consumption of high in calories food products is needed, the legislation should define the reduction in the selling price of food products which are rich in nutritious ingredients – obesity is a multi-factored sickness.
5. There should be a restriction of the advertisements on harmful food types on behalf of the Mass Media and an increase on suitable stimuli about a healthy diet.
6. School should promote the significance of healthy diet through learning subjects and teaching, and through programmes and educational activities about health education. The school canteens are obliged to comply with the rules set by laws.
7. The genetically modified food, although it is not classified in the characterised as balanced diet food types, is expected to be a topic subject for discussion and research in the long run. Those food types should be marked as genetically modified.
8. The balanced way of leading a life is a total of behaviours, habits and practices which contribute to the assurance and retention of a good physically, mentally and emotionally health and wellness.

- For the sub-topic **"Stem Cells – the potential allrounders?"** students could elaborate on the contradicting issues that surround stem cells, the way our lives can be affected with their manipulation and current limits to their manipulation. Some possible resolutions for this sub-topic are:

Points assessed:

1. species of stem cells
2. features / types of stem cells, the building process of stem cells
3. comparing species of stem cells
4. legislation in Greece and Europe
5. religious issues, social, ethical dilemmas for the use of stem cells
6. conflicting opinions regarding the use of stem cells
7. the issue of private vs public
8. tourism issue for stem cell market

Final claims:

1. informing citizens by experts, media / information from school
2. a common law and a common legal framework in all countries
3. establishment- foundation of a joint European Commission
4. use of IPS for further research (using IPS for further research, using morula to produce stem cells
5. intensified monitoring of private banks / strict controls
6. combating tourism through tighter controls

❖ For the sub-topic **"Augmented Human: optimising the human?"** students could discuss and assess aspects and problems related to the current state of optimising the human body by applying prostheses and glasses and the application of new technological advances that are supposed to enhance and modify the human body. Students could reflect on the implications to humans and their skills and the underlying ethical issues that arise. Some possible resolutions for this sub-topic are:

Points assessed:

1. The augmented human as a dual approach: addressing the needs of (1) healthy people and (2) people with special needs.
2. Statistical references to the extent that people nowadays use applications that enable the optimisation and extension of human skills.
3. Scientific achievements that have been accomplished towards 'augmenting' humans.
4. Reference to the need for application of scientific developments for medical treatment and serving people with special needs by making their everyday lives easier.
5. Application of scientific developments for augmented experiences (cultural and educational purposes)
6. Potential dangers of the 'augmented human' technological applications (privacy loss, violation and exploitation of private data, excessive use, social inequality)
7. Legal framework: distinction between ethical and legal framework
8. Considerations for correct use

Final claims:

1. Humans' psychosomatic and intellectual improvement through scientific applications
2. Distinction of practices: (1) facing health problems and (2) enabling the fullest possible reinforcement of people's skills
3. Augmented reality (cultural and educational applications), genome modification
4. Reference to the extent of application use
5. Positive consequences: (disease treatment, financial and entrepreneurial growth, making daily life easier)
6. Strengthening research on issues such as consequences, informing and shaping a moral society
7. Reformation of legal framework; distinction between ethical and legal framework
8. Are human beings ethically ready?

❖ For the sub-topic "**Imitating nature**" students could inquire on the functionality and objectives of synthetic biology, the way scientific advances allow the imitation of new biological pieces, gadgets or systems and potential limits that should be placed in such implementations. Some possible resolutions for this sub-topic are:

Points assessed:

1. Biomimetics (Examples: Velcroà Burdock, Costume bathesàShark's skin, Robots of explorations, Mobile phone screens)
2. Synthetical Biology-Advantages: treatment of diseases, improvement of quality of life, information storage etc./ Drawbacks: creation of pathogenic organisms)
3. Biohacking (Synthetic Biology VS Computers)
4. E-coli (medicine against malaria, which is cheap thanks to Synthetical Biology)
5. Maintenance of our data information

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6. Careful study and intervention about the economic consequences that it may bring about, especially in developing countries
7. Europe is in a lower level compared to America concerning Synthetical Biology and more specifically as far as publications and financing research are concerned
8. Imitation of nature should not only be applied in Medicine, but in other fields too

Final claims:

1. Imitation of nature, Synthetical Biology
2. Legislation (it should watch over the developments and the international rules)
3. Security concerning both the genetic data and the lab operation
4. Limits in the use of natural organisms and products of Synthetical Biology/Patents
5. Public discussion between Academics, labs etc.
6. Public awareness campaign
7. Very fast development (Horizon 2020, iGEM)
8. The issue of Bioethics

5 Learning Activities & Effective Learning Environments

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Science topic: **Biology** (Relevance to national curriculum) **Greek Junior and Senior High School biology curriculum** Class information Year Group: **3rd grade of Junior High School and 1st -3rd grade of Senior High School** Age range: **15-19** Sex: **Mixed** Pupil Ability: **Mixed (The scenario allows space for pupils of various abilities to participate)**	Materials and Resources *What do you need?* **printed evaluation rubrics** *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 in research centers to communicate with experts. Communication with experts will also be realized online. The final debate event will take place in a conference hall to accommodate both participating students but also scientists.** *Health and Safety implications? None* *Technology?* **Computer and internet access and an online platform to facilitate communication with scientific experts and students from different schools** *Teacher support?* ***Scaffolding***
Prior pupil knowledge	

Individual session project objectives *(What do you want pupils to know and understand by the end of the lesson?)* During this scenario, students will **Month 1: Be attracted to engage with topics addressing the 'Future of Human Being'. They form groups depending on the subtopic they have selected that addresses their individual needs and interests. 1) The Human Brain, 2) Living and eating healthy – but how?, 3) Stem cells – the potential allrounders?, 4) Augmented human: optimising the human and 5) Imitating nature. They search the internet to find relevant information.** **Months 2-3: Acquire a deeper understanding of the topics examined and come up with further questions. Together with their group members make a plan on the elaboration of their arguments based on scientific findings and work on possible solutions.** **Month 4: They contact the scientist to discuss their approach and findings. They become aware of what it's like to work as a scientist and the scientific inquiry. They explore alternative solutions and creative ways to build their arguments.** **Month 5: Prepare for their presentation on the final debate event.**		
Assessment **Students are engaged in inter-workgroup assessment processes throughout the preparation phase. They define the assessment criteria that acts as activator of reflection processes, engaging members of the same group to strengthen their arguments**	**Differentiation** *How can the activities be adapted to the needs of individual pupils?* **The SP approach is grounded on the respect for students' needs and interests as a cornerstone for its successful realisation. The selection of the topic and the exploration of relevant issues depend on students. During the inquiry phase all students will participate and contribute with relevant to their interest data.**	**Key Concepts and Terminology** **Science terminology: stem cells, cognitive impairment, mutants, Biomimetics, bioethics, augmented human, genome modification, prostheses, implants** **Arts terminology: modelling (digital or physical), drawings, videos**

Session Objectives:

During this scenario, students will

Deepen their understanding on issues relevant to the future of human being

Learning activities in terms of CREATIONS Approach

IBSE Activity	**Interaction with CREATIONs Features**	**Student**	**Teacher**	**Potential arts activity**
Phase 1: **QUESTION:** students investigate a scientifically oriented question	Students pose, select, or are given a scientifically oriented question to investigate. *Balance and navigation* through *dialogue* aids teachers and students in creatively navigating educational tensions, including between open and structured approaches to IBSE. Questions may arise through *dialogue* between students' scientific knowledge and the scientific knowledge of professional scientists and science educators, or through *dialogue* with different ways of knowledge inspired by *interdisciplinarity* and personal, embodied learning. *Ethics and trusteeship* is an important consideration in experimental design and collaborative work, as well as	✓ Build interest in scientific issues and their explanations/social impact. ✓ engage with open-ended inquiries related to their lives. ✓ use the web to explore the 'future' of human beings. ✓ Understand science as a process not as stable facts	The teacher tries to attract the students' attention by eliciting students' relevant questions or pinpoint unexplored areas to the topic under negotiation. What does the 'Future of human beings' mean to you? Which of these issues (human Brain, Living and eating healthy, Stem cells, Augmented	What do we want to find out/now about these issues? What do you know about these? What if you could predict their implementation in the future?

	in the initial choice of question.		human, Imitating nature) would you like to further explore?	
Phase 2: **EVIDENCE:** students give priority to evidence	Students determine or are guided to evidence/data, which may come from *individual, collaborative and communal activity* such as practical work, or from sources such as data from professional scientific activity or from other contexts. *Risk, immersion and play* is crucial in *empowering* pupils to generate, question and discuss evidence.	✓ Plan and conduct simple investigation ✓ experiments are conducted to explore different answers following observation, data collection and interpretation,	The teacher identifies possible misconceptions.	Students make a collage of snapshots (taken from videos, journals, etc.) explaining the state of the art with reference to the thematic topic they're exploring. Students may outline evidence in a form of storytelling (eg. How scientific progress in the specific field has affected (improved or deteriorated a person's life).

Phase 3: **ANALYSE:** students analyse evidence	Students analyse evidence, using *dialogue* with each other and the teacher to support their developing understanding.	✓ Students engage in analysing data (organizing data, finding patterns, assessing data quality), interpreting data, making inferences, modeling, etc.).	Teacher divides students in groups. Each group of students formulates and evaluates explanations from evidence to address scientifically oriented questions.	Implementing modellisation, facilitating students to express in alternative ways their analysis.
Phase 4: **EXPLAIN:** students formulate an explanation based on evidence	Students use evidence they have generated and analysed to consider *possibilities* for explanations that are original to them. They use argumentation and *dialogue* to decide on the relative merits of the explanations they formulate, *playing* with ideas.	Each group of students evaluates its explanations in light of alternative explanations, particularly those reflecting scientific understanding.	Acts as a facilitator of the process	Provide creative examples/models/ drawings to strengthen their explanations.
Phase 5: **CONNECT:** students connect explanations to scientific knowledge	Students connect their explanations with scientific knowledge, using *different ways of thinking and knowing* ('knowing that', 'knowing how', and 'knowing this') to relate their ideas to both disciplinary knowledge and to *interdisciplinary* knowledge to understand the origin of their ideas and reflect on the strength of their evidence and explanations in relation to the original question.	Explore the topic spherically and find connections with other disciplines (eg technology, medicine, engineering). Exploration of new areas according to students' interests	Allows room and enhances connectivism with other disciplines	Creativity in identifying connectivism and providing possible solutions.

Phase 6: **COMMUNICATE:** students communicate and justify explanation	Communication of *possibilities*, ideas and justifications through *dialogue* with other students, with science educators, and with professional scientists offer students the chance to test their new thinking and experience and be *immersed* in a key part of the scientific process. Such communication is crucial to an *ethical* approach to working scientifically.	Each group of students produces a report with its findings, presents and justifies its proposed explanations to other groups, the teacher and scientific expert. To facilitate students' editing their scientific report, they are provided with specific guidelines and template for their presentation (eg. Topic, definition of key elements, methodology applied for preparation of the scientific topic, current developments, statistics, legislation, different dimensions of the issue, main arguments in favour and against the issue, key stakeholders, scientists involved, links for additional resources, etc.). The group of students designs a presentation of their claims and alternative models for their illustration.	Both scientists and teachers provide guidelines for presentation. Assess pupil's knowledge.	Creative presentation of scientific issues. Design and structure of alternative models/videos (possible future scientific applications: eg. model of shell houses floating in the sea to face urbanization).

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Phase 7: **REFLECT:** students reflect on the inquiry process and their learning	*Individual, collaborative and community-based* reflective *activity for change* both consolidates learning and enables students and teachers to balance educational tensions such as that between open-ended inquiry learning and the curriculum and assessment requirements of education.	Become acquainted with parliamentary decision-making processes as well as scientific research grounded on the model of Inquiry-based learning and develop life-long and communicative skills by engaging in dialogue and debate processes aiming at the exchange and sharing of scientific points of view. Students use the argumentation approach to back up their claims by developing warrants and refute their peers' contradictory arguments. The debates' inner element of assessment between the opponents sets the ground for reflection.	Assess pupils' understanding	Depending on the science topic, as a stimulus, pupils present any issues, ethical concerns or consequences surrounding this topic as a story line for a dramatic scene to communicate understanding and conflicting views about the topic.

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6 Additional Information

During the students' preparation phase, all participants are supported by experts in the specific fields that share and exchange their ideas and communicate with the students and teachers.

Teachers work with science centre scientists/researchers to create and plan open-ended investigations for their students. The science centre scientists/researchers then support the teachers to carry out these plans in the classroom. Students carry out open-ended practical work that is closely linked to the curriculum and to their everyday experiences of science. Theory is carefully integrated into the practical sessions by the teachers and assessment is realized through observation and conversations with students about the key scientific concepts they are exploring. Application of students' scientific constructs and creative presentation is realized and further assessed in the final debate event.

In addition, during the students' preparation phase, scientific experts support students in their inquiry phase by providing them with links (articles, videos, simulations, etc), guiding them in a holistic exploration of the issue under negotiation.

Some suggested links that experts provided in relation to each thematic sub-topic are the following (further links were provided in students' native language-Greek):

The Human Brain

- P300 Evoked Potential in Patients with Mild Cognitive Impairment
- The clinical utility of the auditory P300 latency subcomponent event-related potential in preclinical diagnosis of patients with mild cognitive impairment and Alzheimer's disease
- Neuropsychological correlates of the P300 in patients with Alzheimer's disease
- Cognitive decline effects at an early stage: Evidence from N170 and VPP
- Electroencephalography and event-related potentials as biomarkers of mild cognitive impairment and mild Alzheimer's disease
- Correlation of auditory event-related potentials and magnetic resonance spectroscopy measures in mild
  cognitive impairment
- Auditory event-related potentials during target detection are abnormal in mild cognitive impairment
- Human Brain: Facts, Anatomy & Mapping Project
- Virtual reality maze 'predicts Alzheimer's disease'(BBC)
- Online brain training 'helps older adults with everyday tasks' (BBC)

Living and eating healthy – but how?

- Adopt a Mediterranean diet now for better health later
- Healthy Lifestyle: Nutrition and healthy eating
- Alzheimer's: Can a Mediterranean diet lower my risk?
- Mediterranean diet may prevent breast cancer, but there are other reasons to pour on the olive oil
- Genetically modified crops

- Frequently asked questions on genetically modified foods
- Questions and Answers on the Regulation of GMOs in the European Union
- Evaluation of Allergenicity of Genetically Modified Foods
- Safety aspects of genetically modified foods of plant origin
- Guidelines on food fortification with micronutrients
- Food safety
- How safe is your food? From farm to plate make food safe
- Food Today on Nutrition Labelling
- Proceedings: Workshop 'Eat for Health'. European Parliament
- The European Food Information Council

Stem cells – the potential allrounders?

- Stem cell therapy: hype or hope? A review
- Explore Stem Cells
- What are stem cells by MNT
- Stem Cell Basics: Educational cartoon for young learners
- Stem cell controversy
- Stem cell facts by ISSCR
- What is a stem cell? by the Canadian Stem Cell Foundation
- Frequently Asked Questions on stem cells by ISSR
- Presentation: The Nature of Stem Cells
- News about Stem Cells, including commentary and archival articles published in The New York Times
- Pros and cons of stem cell research
- Defining a Life: The Ethical Questions of Embryonic Stem Cell Research
- The Ethical Questions of Stem Cell Research
- Embryonic stem cell research: an ethical dilemma
- Stem cell controversy by Wikipedia
- Ethical Issues on stem cell research
- Ethics of Stem Cell Research
- Stem Book (Harvard Stem Cell Institute)
- Stem Cell Basics (U.S. Department of Health & Human Services)

Augmented human: optimising the human

- "How Technology Transforms Lives"
- The Wearable Era Is Here
- 10 Ways the Next 10 Years Are Going To Be Mind-Blowing
- Is Google working on a cure for cancer?

- Human enhancement (Wikipedia)
- European Parliament. Science and Technology Options Assessment
- Machine 'Learns' Like A Human Brain (NDTV)

Imitating nature

- Biomimetics (Wikipedia)
- Technology that imitates nature (The Economist)

Additional information on the SP approach:

http://www.scienceview.gr/projects/

http://studentparliament.weebly.com/thetaepsilonmualphatauiotakappa941sigmaf-epsilonnu972tauetatauepsilonsigmaf.html

http://www.opendiscoveryspace.eu/community/greek-student-parliament-science-834221

http://pubs.sciepub.com/education/3/12/20/

7 Assessment

Both quantitative and qualitative data are required to assess students' and teachers' cognitive and creative development through the implementation of the SP Demonstrator. For quantitative assessment we recommend the use of the 'Science Motivation Questionnaire II (SMQ-II)'[1] (Glynn, et al., 2011; Maximiliane, Schumm, Bogner, 2016) that is addressed to students and the 'VALNET' questionnaire addressed to teachers.

In the context of the SP, the students' qualitative assessment process follows a dual structure: (a) inter-workgroup assessment that acts as activator of reflection processes, engaging members of the same group to strengthen their arguments and (b) external –workgroup assessment that follows the principles and guidelines of a structured parliamentary debate. In the latter case, debate itself features an inner assessment element; the best and most validated (scientifically evident) arguments are the most persuasive (in scientific debates) and inevitably prevail.

In both cases students' development of argumentation skills (Claim, Data, Warrant/Reason, Rebuttal) (Scholinaki et al., 2014; Smyrnaiou et al., 2012) is traced and assessed through evaluation rubrics that have been decided and defined by students themselves. This way, assessment criteria setting acts as a mechanism that triggers and enhances students' in-depth knowledge of argumentation structure and scientific inquiry in order to construct a rational scale of assessment grounded on scientific evidence and argumentation.

For students' structuring an evaluation rubric we suggest the inclusion of all relevant to the SP concept parameters as key aspects of engaging students in the development of scientific arguments: the development of argumentation skills, the assessment of scientific inquiry, the collaboration applied among the members of the same team, the development of communicative skills, communication of scientific concepts, communication with scientists and the development of exchange of information/knowledge skills.

As an exemplary case, we present the following assessment rubric that addresses both types of assessment: inter-workgroup and external –workgroup assessment.

SP's assessment rubric

(a) Development of argumentation skills

- ✓ Having framed the argument, what supporting data do I choose to reinforce my argument? (eg examples, statistics, expert opinions etc.)
- ✓ Argument Rating (Valid, invalid, true, false)
- ✓ Evaluation of supporting data
- ✓ With reference to the counterargument: do I draw material from the same subject-topic? Is there a direct correspondence between argument and counterargument?

(b) Development of dialogic/information/opinion exchange skills

- ✓ All sides have equally expressed their opinions?

[1] 2011 Shawn M. Glynn, University of Georgia, USA http://www.coe.uga.edu/smq/

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- ✓ Arguments were relevant
- ✓ Arguments were developed with clarity
- ✓ There was appropriate use of the language code (Avoiding digressions, unjustified peroration, precise argument wording, use of adequate vocabulary/scientific terms, proficiency in documentation)
- ✓ Showing respect for different views
- ✓ Complying with the debate rules (Equal time, equal groups, etc.)
- ✓ Use of non-linguistic elements (Eg gestures, gaze, facial expressions, posture, movements)
- ✓ The climate during the conduct of the debate

(c) Communication with scientists (learning to derive useful information)

- ✓ Inquiry to identify questions to address to scientists
- ✓ Issues and ideas generated after the communication with scientists
- ✓ Acquired knowledge beyond the specific domain after the communication with scientists
- ✓ The communication with scientists has affected:
  - their subject approach
  - scientific thinking
  - use of scientific language (E.g. learned vocabulary, tried to imitate the scientist's speech etc.).

(d) Development of public discourse / parliamentary / communication skills

- ✓ Adoption of different linguistic styles (Eg change in style, intonation of voice, etc.)
- ✓ Successful communication/ utterance of arguments, focus on clarity
- ✓ Challenging and interesting elaboration of arguments

(e) Creative communication

Record two or three examples with reference to creative ways of communication:

• Verbal Communication (eg. examples from other domains)

• Embodied communication of scientific concepts (using any part of the body eg facial expressions, gestures, etc.)

(f) Communication of scientific concepts

- ✓ Acquisition of scientific knowledge
- ✓ Explanation of scientific concepts in a creative way
- ✓ Able to give examples from their personal life
- ✓ Reference of current findings/state of scientific research
- ✓ Connection with other domains

Debate process and Resolution Evaluation

For the actual realization of the final debate, students should be provided with specific guidelines for its procedure, following seven procedural steps (Appendix): (1) Reading out the claims, (2) Defense speech, (3) Attack speech(es), (4) Response to attack speech(es), (5) Open debate, (6) Summarising speech, response to last questions and (7) Voting. Groups of students / Schools that will have negotiated the same topic will have to discuss and decide on the final claims/resolutions that would comprise their final argumentation basis. First, at the beginning of each debate, the proposing committee has the opportunity to read out the committee's claims which are gathered in a structured resolution booklet template. Subsequently, the proposing committee has the opportunity to hold a defense speech and explain the existing resolution and its contents. All committees are given the opportunity to hold one or more attack speeches to elaborate and explain why some of the claims should not be accepted by the delegates. Next the proposing committee has the opportunity to give answers to the attack speech and to allay doubts the delegates might have. During the process, all members of all opposing committees (addressing all 5 subtopics) can raise their hands to address questions or remarks to the proposing committee which is required to give a summarising answer to all of them. Next, the proposing committee will hold a summarising speech and answer the last questions and finally the chair of the debate reads out the claims and asks all delegates to vote for or against a claim.

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8 Possible Extension

The SP demonstrator is an exemplary case on how argumentation is situated in science education and its beneficial contribution in advancing students' understandings of the epistemology of science. In order to initiate students into the principles of authentic scientific practice students should be engaged in meaningful and challenging activities and learning processes that are guided by the epistemology of science. A key element that guides SP concept is its flexible nature with reference to the thematic area selection for negotiation and debate. A principle that needs to be pursued is the challenging nature of the topic and the need to address students' interests and be connected with their lives. Therefore, following the SP's guidelines various socioscientific issues can serve as useful contexts for teaching and learning science content by enhancing the acquisition of specific content knowledge and understanding of the nature of science. The topics for negotiation have to be selected according to their challenging factor and their centrality to contemporary scientific issues and problems that need solving. Such topics raise questions of high complexity and are subject to ongoing inquiry, requiring for their negotiation, cognitive reasoning and reflective judgment. In addition, they facilitate the development of multiple, alternative approaches and provide a perspective for incorporating new knowledge into existing knowledge.

Another extension of great beneficial educational outcome - given the communicative nature of the SP's approach - would be to extend the SP's activities at an international level involving the engagement and exchange of scientific ideas and alternative solutions among students of different countries. This way, students will have the opportunity to identify and reflect on potential cultural differences in scientific approaches and share and exchange opinions about ethics that underlie current scientific issues. But most of all, they will acquire a first-hand experience of belonging to an international network/community of peers; inquiring and attempting to solve issues that directly affect our lives.

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APPENDIX

Procedure of the debate

1. **Reading out the claims**
   At the beginning of each debate, the proposing committee has the opportunity to read out the committee's claims which are gathered in this resolution booklet. *(One member of the proposing committee reads out the claims at the lectern.)*

2. **Defence speech**
   Subsequently, the proposing committee has the opportunity to hold a defence speech and to explain the existing resolution and its contents. *(One member of the proposing committee reads holds the speech at the lectern; approx. three minutes.)*

3. **Attack speech(es)**
   Directly after, all other committees have the opportunity to hold one or more attach speeches, provided that the first attack speech does not take up all time. Every committee which has prepared an attack speech can now explain why some of the claims should not be accepted by the delegates. *(One member of an opposing committee; up to three minutes at own seat/via microphone.)*

4. **Response to attack speech(es)**
   The proposing committee has the opportunity to give answers to the attack speech and to allay doubts the delegates may have. *(One member of the proposing committee; up to one minute at own seat/via microphone.)*

5. **Open debate**
   All members of all opposing committees can raise their hands to address questions or remarks to the proposing committee. Up to three questions/remarks are gathered from members of the different committees, before the proposing committee can give a summarising answer to all of them. *(Up to four rounds à three questions/remarks of less than a minute; at own seat/via microphone.)*

6. **Summarising speech, response to last questions**
   The proposing committee holds a summarising speech and answers the last questions. *(Two members of the proposing committee; three minutes at the lectern.)*

7. **Voting**
   The chair of the debate reads out the claims and asks all delegates to vote for or against a claim.