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/).

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

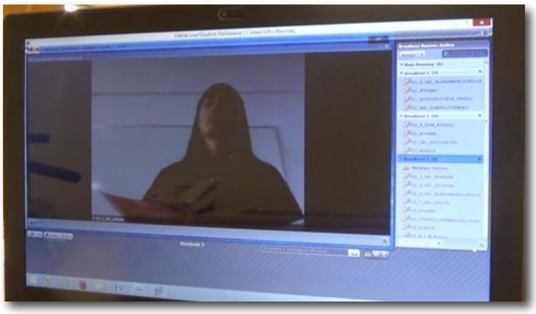
The demonstrator's main aim is "to strengthen the dialogue and exchange of ideas between students and scientists, introduce students to parliamentary procedures on science and research, enabling students to form a qualified opinion and to assess complex topics, and introduce students to a scientific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



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.

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5 Learning Activities & Effective Learning Environments

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<tr>
<td>
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)
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<td>
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
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<tr>
<td colspan="2">Prior pupil knowledge

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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 critreria 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:**

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 in the initial choice of question.	✓ 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.	

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.	
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.	

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	Both scientists and teachers provide guidelines for presentation. Assess pupil's knowledge	Creative presentation of scientific issues. Design and structure of alternative models

		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.		
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/

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7 Assessment

In the context of the SP, the 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.

As an exemplary case 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?
- ✓ 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

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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