

**Write a Science Opera (WASO) Demonstrator**

**Project** 665917

**Reference:**

**Code:** D 3.1

**Version & Date:** 1.0 / May 27<sup>th</sup>, 2016

**Author:**

Oded Ben-Horin (HSH)

**Contributors:**

**Approved by:**

**Write a Science Opera (WASO): 2-day workshop aimed at school implementation of Science Opera on the subject of elementary particles. This demonstrator builds upon the WASO training material(s) of previous projects which have made the material publicly available (EC CREAT-IT, 2015).**



## Table of Contents

1	Introduction / Demonstrator Identity.....	4
1.1	Subject Domain .....	4
1.2	Type of Activity.....	4
1.3	Duration.....	4
1.4	Setting (formal / informal learning) .....	4
1.5	Effective Learning Environment .....	4
2	Rational of the Activity / Educational Approach.....	6
2.1	Challenge .....	6
2.2	Added Value .....	6
3	Learning Objectives.....	7
3.1	Domain specific objectives .....	7
3.2	General skills objectives .....	7
4	Demonstrator characteristics and Needs of Students.....	9
4.1	Aim of the demonstrator .....	9
4.2	Student needs addressed.....	9
5	Learning Activities & Effective Learning Environments .....	10
6	Additional Information .....	16
	Warm-ups.....	16
	<b>STRETCHING EXERCISES</b>	<b>16</b>
	<b>BREATHING EXERCISES</b>	<b>16</b>
	<b>NAME GAMES</b>	<b>17</b>
	<b>COUNTING GAME</b>	<b>17</b>
	<b>MOVEMENT EXERCISE (1) - “FRIENDS!”</b>	<b>17</b>
	<b>MOVEMENT EXERCISE (2) - “LOBSTERS!”</b>	<b>17</b>
	<b>MOVEMENT EXERCISE (3) – “HAND ON RED!”</b>	<b>18</b>
7	Assessment .....	19

8 Possible Extension..... 20

9 References ..... 21



### 1 Introduction / Demonstrator Identity

#### 1.1 Subject Domain

Subject domain may include all areas of STEM, as well as a multi-disciplinary approach to arts which includes visual arts, music, drama, lighting design, and more.

#### 1.2 Type of Activity

Write a Science Opera (WASO) is a creative professional development approach to inquiry-based science and art education in which pupils of different ages, supported by teachers, artists and scientists, are the creators of an educational performance. This demonstrator relates to training for European teachers which can be realized in a school, community, arts institutions, etc.



WASO workshop with teachers from Belgium and Holland (2015)

#### 1.3 Duration

This demonstrator describes a 2-day training workshop.

#### 1.4 Setting (formal / informal learning)

WASO is open to all kinds of educational frameworks. Most of the activities thus far have involved formal learning settings, especially late-primary and early-secondary schools. The method is open to include informal learning environments.

#### 1.5 Effective Learning Environment

This demonstrator relates to the following categorizations (see CREATIONS D2.3 for further detail):



- **Arts-based** which addresses and enhances scientific interconnection of science with aspects of art
- **Dialogic space / argumentation** aiming to engage students in argumentation and dialogic processes for a better insight into the nature of scientific enquiry and the ways in which scientists work

The WASO training described here typically takes place with several teachers from a single school, or with several teachers from a municipality who converge in one school (or other institutions such as university) in order to take part in the training.

When realized in schools, the WASO learning environment is collaborative, creative and flexible. It includes much movement (e.g. drama exercises), and approximately halfway through the project the class is divided into groups to create an “opera company” (orchestra, PR group, singers, light specialists, etc.). This structure implies a non-typical classroom situation at times which resembles a “workshop” atmosphere, and in which unexpected questions and situations may arise, as the pupils begin to take charge of the learning process and the communication of that learning.



### **2 Rational of the Activity / Educational Approach**

#### **2.1 Challenge**

*WASO offers an inherently creative design which stimulates creativity in the Inquiry-Based Science Education (IBSE) setting. It thus responds to challenges in today's schools regarding the rate of uptake of IBSE, the strengthening of creative approaches to learning in schools, and the need for an intuitive engagement of social and emotional skills in the science classroom in order for the science classroom to become more engaging. In this specific demonstrator, the field of Particle Physics is explored.*

#### **2.2 Added Value**

WASO provides learning opportunities in which pupils may cross-inspire and learn from and with each other in a creative school environment. In the proposed two-day workshop, teachers will gain techniques to support their ability to engage pupils in science inquiry in new, creative ways. Pupils will, during implementation in schools following the training workshop, be able to explore scientific questions through drama, music and visual arts. In this way they will gain access to the scientific material which is being taught from a large variety of perspectives.

### 3 Learning Objectives

#### 3.1 Domain specific objectives

The scientific theme of this demonstrator is to explore elementary particles: photons, Higgs Boson, Neutrinos.

In the arts education domain, the objectives are to learn school opera as a methodology, including specific skills and inquiry with the various included arts education domains (music, drama, scenography, light design, etc.).

More specifically, teachers will learn how to guide their pupils so that they will be able to:

- Finalize and perform a multi-disciplinary artistic performance (school opera) which demonstrates and deepens scientific and emotional understanding of the star rotation scenario learning processes, supporting discipline knowledge in both the science and arts educational disciplines.
- Engage in activities which inspire curiosity around elementary particles; Explore musical, visual design, drama techniques as tools for the opera. *Note: Teachers may decide the science opera's theme before the project or allow pupils to choose the scientific theme themselves. Each approach has its advantages: In the case in which the teacher chooses the theme prior to the project, it will be possible to realize the project during a shorter time-span. On the other hand, pupils may experience greater ownership and agency if they are allowed to choose the opera's theme themselves. In both cases (teacher choice or pupils' choice) it is important and motivating that the pupils investigate their own questions connected to the chosen theme.*
- Gain knowledge and experience with group-work in which various groups will create specific synopsis, libretto, composition, scenography, costumes for the Science Opera, accompanied by a continued exploration of particles. Students will learn to create specific synopsis, libretto, composition, scenography, costumes for the Science Opera. Continued exploration of scientific topics. *The libretto should include key concepts connected to the scientific theme. Scientific models and figures can be of great inspiration to scenography, costumes and music.*

#### 3.2 General skills objectives

The objective of skills may be seen as developing social and emotional skills, cognitive skills, and, especially, meeting points between these, within an international context. Creativity and critical thinking, both considered to be “21<sup>st</sup> century skills”, may largely be said to occur in the interaction, and cross-fertilization between these groups of skills (OECD, 2015).



Specific skills:

- Active participation in the negotiation of scientific concepts
- Developing creative and critical skills
- Understanding of scientific concepts and phenomena
- Scientific interconnection of science with aspects of art (students will undergo a multi-disciplinary artistic process which demonstrates and deepens understanding, supporting discipline knowledge in both the science and arts educational disciplines).
- Developing a spirit of cooperation and teamwork
- Connecting the science classroom with research infrastructures
- digital competencies



### **4 Demonstrator characteristics and Needs of Students**

#### **4.1 *Aim of the demonstrator***

The aim of the demonstrator is to describe the WASO methodology for implementation, explore further its challenges and opportunities, and support its implementation within the CREATIONS project.

#### **4.2 *Student needs addressed***

Needs addressed are the creation of a Living Dialogic Space within creative science exploration, and rigorous engagement with Possibility Thinking (see CREATIONS Deliverable 2.1). Furthermore, there is a need to explore scientific material from the point of view of a variety of disciplines, such as drama, music, and visual arts. The CREATIONS project conceptualizes creativity at the meeting point of these domains, something which is exemplified in this demonstrator.

### **5 Learning Activities & Effective Learning Environments**

WASO exercises a flexible implementation, which is adaptable to the specific school's time schedules, priorities, etc. WASO may be implemented with pupils as an intensive 2-week project in formal schools, as a short session over the course of a whole school year, or as an afternoon project in informal settings. The WASO school class simulates an “opera company” in which performers, composers, designers, scenographers, science educators, etc., collaborate to create an opera. There is therefore no “one size fits all” approach to the activity. Typically, though, a teacher will choose a scientific theme (in this case, star rotation), and engage the pupils in inquiry-based activities within both science and the arts.

For implementation in schools, the following may be required:

1. 2 classroom spaces (1 may be enough in some cases)
2. Musical instruments
3. Raw material for costumes
4. Stage (optional – WASO may be performed without an official stage)
5. Audio equipment for performance (optional – WASO can be performed “unplugged”)
6. Access to scientific information (teacher/internet/book/research center)

The table below provides an outline for a WASO 2-day training seminar, in which teachers will participate in the process which they will thereafter guide their pupils in. Each phase (of 7 phases) will, during this training, last for 1-2 hours. Please note that when you will be implementing this intervention with pupils, it is recommended to take longer stretches of time. Optimally, a class would allocate 2 whole weeks to the WASO project. Alternatively, a teacher could opt to develop the WASO intervention over longer (e.g. one school year) periods, but rather engage with it for 2 hours a week.

<p>Science topic: Elementary particles in the world of art: <a href="http://artcms.web.cern.ch/artcms/">http://artcms.web.cern.ch/artcms/</a></p> <p>Class information</p> <p>Year Group: 8-10</p> <p>Age range: 13-15</p> <p>Sex: both</p> <p>Pupil Ability: The scenario allows space for pupils of various abilities to participate, e.g. pupils with language difficulties may contribute on an equal level to others by performing in the orchestra.</p>	<p>Materials and Resources</p> <p><i>What do you need?</i> Various music instruments, materials for making costumes. Optional: Stage, lights</p> <p>Where will the learning take place? On site or off site? In several spaces? (e.g. science laboratory, drama space etc), or one? Following a virtual visit to CERN, learning can take place in school and/or at science education center or museum. It is a good approach to have several rooms available during the phase where pupils are split into groups (see WASO Guidelines (Ben-Horin, 2014)).</p> <p><i>Health and Safety implications?</i> In the case of sewing costumes, it is important to ensure maximum safety by having a qualified teacher available at all times and corresponding instructions.</p> <p><i>Technology?</i> Computer with internet (watching videos and searching for information). This is especially important during virtual visit to CERN if applicable.</p> <p><i>Teacher support?</i> Team teaching with both arts and science and arts (music\dance\design\drama) expertise is recommended.</p>
<p>Prior pupil knowledge</p>	
<p>No prior knowledge regarding particles is required for pupils. The idea of the demonstrator is to introduce the topic through the creation of the opera. Mathematics skills (calculations) will be needed. If pupils do have prior knowledge about elementary particles, they will still be able to profit from engaging with the scenario, but they will probably think about it in a deeper way.</p> <p>No prior knowledge regarding the arts is needed for pupils. The WASO method caters to all pupils, and includes exercises in e.g. music composition which allow novices to compose simple sections of the opera.</p> <p>Optional: music lessons including composition exercises; basic drama exercises; dance; arts &amp; crafts classes; experience with school stage performances is an advantage</p>	



### Assessment

The CREATIONS project ([www.creations-project.eu](http://www.creations-project.eu)) proposes guidelines for the assessment of activities with pupils and teacher training. Please refer to the website in order to access the relevant documents.

### Differentiation

*How can the activities be adapted to the needs of individual pupils?*

Teachers who have undergone WASO training will explore a variety of tools which may be chosen according to the needs of various pupils and levels of difficulty. Examples (science): Level of depth of scientific explorations / amount of phenomena chosen as topics.

Examples (arts): choice of tonality, level of rhythmical complexity of songs, etc.

### Key Concepts and Terminology

#### Science terminology:

Higgs Boson, Photons, Neutrinos, Mass, Light.

#### Arts terminology:

1) Aria: Solo song by one character. The plot's "action" is stopped to allow this character to express a certain emotion and inner feelings.

2) Duet: Two singers, preferably each singing their own verse followed by a section in which they sing together.

3) Ensembles: Three or more singers

4) Choir: The choir can be used to "comment" during the other songs, or as simple choir pieces.

5) Overture: Instrumental (no voices) opening piece which sets the mood of the opera.

6) Interlude: Music performed between acts or scenes.

7) Recitative: "Spoken Song" which tells a story, and which propels the plot further by revealing action (what has taken place, what will take place, a secret, etc.).

8) Tableau– A dramatic activity in which a group of pupils are asked to physically construct an opera scene through body placement, facial expressions, and props

9) Various musical instruments



Session Objectives:

During this scenario, students will:

Explore the art@CMS website, and learn about modern research concerning the relevant particles (Neutrinos, Photons, Higgs Boson); Take part in a virtual visit to CERN; Experience musical, visual design, drama techniques as tools for the opera.

Students will gain knowledge and experience with group-work in which various groups will create specific synopsis, libretto, composition, scenography, costumes for the Science Opera, accompanied by a continued exploration of the particles. The libretto should include key concepts connected to the scientific theme. Scientific models and figures can be of great inspiration to scenography, costumes and music.

Throughout the scenario, pupils will learn to make their own decisions during inquiry processes, make their own connections between questions, planning and evaluating evidence, and reflect on outcomes.

### Learning activities in terms of CREATIONS Approach

IBSE Activity	Interaction with CREATIONS Features	Student	Teacher	Potential arts activity
<p><b>Phase 1:</b> <b>QUESTION:</b> students investigate a scientifically oriented question</p>	<p>Students pose, select, or are given a scientifically oriented question to investigate. <i>Balance and navigation</i> through <i>dialogue</i> aids teachers and students in creatively navigating educational tensions, including between open and structured approaches to IBSE. Questions may arise through <i>dialogue</i> between students' scientific knowledge and the scientific knowledge of professional scientists and science educators, or through <i>dialogue</i> with different ways of knowledge inspired by <i>interdisciplinarity</i> and</p>	<p>Generate and writes down words\ideas about Neutrinos, Photons, Higgs Boson, and shares with others in order to learn from their previous knowledge.</p>	<p>Activates previous knowledge in the fields of scientific exploration, and introduces particles by means of a</p>	<p>Begin cooperation with music/fine arts/drama/dance teacher(s) at your school in order to explore those subjects. Examples:</p>



	personal, embodied learning. <i>Ethics and trusteeship</i> is an important consideration in experimental design and collaborative work, as well as in the initial choice of question.		virtual visit to CERN.	experimenting with various musical instruments and drama techniques.
<b>Phase 2:</b> <b>EVIDENCE:</b> students give priority to evidence	Students determine or are guided to evidence/data, which may come from <i>individual, collaborative and communal activity</i> such as practical work, or from sources such as data from professional scientific activity or from other contexts. <i>Risk, immersion and play</i> is crucial in <i>empowering</i> pupils to generate, question and discuss evidence.	Students compare their ideas to existing evidence. Take part in virtual visit to CERN.	Guide students to relevant evidence.	Comparing artistic ideas to other artworks, especially school art works created by pupils. Give preference to art projects inspired by scientific phenomena.
<b>Phase 3:</b> <b>ANALYSE:</b> students analyse evidence	Students analyse evidence, using <i>dialogue</i> with each other and the teacher to support their developing understanding.	Students analyse evidence and make conclusions regarding their own initiative.	Help students interpret the potential implications of the evidence for the students' own inquiry.	Begin creating and rehearsing the opera within the various arts disciplines (libretto, costumes, music, etc.)
<b>Phase 4:</b> <b>EXPLAIN:</b> students formulate an explanation based on evidence	Students use evidence they have generated and analysed to consider <i>possibilities</i> for explanations that are original to them. They use argumentation and <i>dialogue</i> to decide on the relative merits of the explanations they formulate, <i>playing</i> with ideas.	Formulations of scientific explanations.	Guide students in their consideration of possibilities.	Continued production of original material (music, etc.), and opera rehearsals.



<p><b>Phase 5:</b></p> <p><b>CONNECT:</b> students connect explanations to scientific knowledge</p>	<p>Students connect their explanations with scientific knowledge, using <i>different ways of thinking and knowing</i> ('knowing that', 'knowing how', and 'knowing this') to relate their ideas to both disciplinary knowledge and to <i>interdisciplinary</i> knowledge to understand the origin of their ideas and reflect on the strength of their evidence and explanations in relation to the original question.</p>	<p>Formulating ideas in relation to discipline knowledge in a larger context, including how scientific and artistic ideas may cross-fertilize each other within the inquiry process.</p>	<p>Ensure scientific quality with regard to explanations</p>	<p>Continued rehearsals, costumes making.</p>
<p><b>Phase 6:</b></p> <p><b>COMMUNICATE:</b> students communicate and justify explanation</p>	<p>Communication of <i>possibilities</i>, ideas and justifications through <i>dialogue</i> with other students, with science educators, and with professional scientists offer students the chance to test their new thinking and experience and be <i>immersed</i> in a key part of the scientific process. Such communication is crucial to an <i>ethical</i> approach to working scientifically.</p>	<p>Students communicate their knowledge and explore its ethical implications.</p>	<p>Supports the communication process and the opera performance logistics</p>	<p>Opera performance: It is advised to invite community (parents, other teachers, etc.), and to include a short introduction by the pupils prior to the performance.</p>
<p><b>Phase 7:</b></p> <p><b>REFLECT:</b> students reflect on the inquiry process and their learning</p>	<p><i>Individual, collaborative and community-based</i> reflective <i>activity for change</i> 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.</p>	<p>Reflection process regarding the scientific and artistic conclusions</p>	<p>Discuss the implications of a global collaboration with students</p>	<p>Reflection on the process, and collection of documentation of data to the extent possible / sharing experiences via social media.</p>



### 6 Additional Information

The WASO Guidelines (Ben-Horin, 2014) provide a detailed overview of drama, music and other exercises, techniques, and more. Those guidelines were developed as part of the European Commission's "Implementing Creatives Strategies into Science Teaching" (CREAT-IT, 2014). The following warm-ups are provided here as reference:

#### *Warm-ups*

Warm-ups provide physical motion (stretching, running, breathing exercises, etc.), musical exercises (rhythm/pulse exercises), vocal training, creative exploration, as well as positive social exchange and group dynamic.

Sessions should begin with a warm-up, regardless of the session's length.

In the list below, some basic exercises are provided. In addition, teachers of physical education, drama, music and dance in your school will usually be able to add their own repertory of exercises.

#### **Stretching Exercises**

Begin with very simple stretching for a variety of areas of the body:

- 1) Roll shoulders in circular motion 3 times in each direction (forwards and backwards).
- 2) Roll head in circular motion 3 times in each direction (left and right). NB: Slowly!
- 3) Facial grimaces to stretch all face muscles (20-30 seconds).
- 4) Massage face, neck and back of neck with fingers (20-30 seconds).
- 5) Stand in a circle with each pupil's left shoulder facing out of the circle so that all pupils are facing the same direction in the circle. Ask each pupil to give her/his neighbor a shoulder and back massage for one minute. Thereafter, switch directions and repeat the exercise.
- 6) Pupils put hands together and reach as high as possible, on tip-toe. Count to 10 as they stand there. Repeat with eyes closed.

#### **Breathing Exercises**

Begin with very simple breathing exercises:

- 1) Pupils inhale (nose) with mouth closed while teacher counts to 4. They exhale (mouth) while teacher counts to 4. *When this exercise has been completed, proceed to 6, then 8. For pupils age 12 or older, proceed to 10.*
- 2) Inhale (nose) and, following teacher's cue, exhale for as long as possible on the sound "ss". Repeat the same exercise with the sound "sh", and then "f".
- 3) Create various rhythms which blend nasal inhalation and mouth exhalation. *Note: These should be very short (3-4 seconds at most).*



### Name Games

This game allows new groups to become acquainted with each other, while simultaneously allowing each member to present him/herself, see each other, and enhance group communication.

Step 1: Invite a group-member to say his/her name. The whole group then repeats that name, after which the next member says his name, and so on.

Step 2: Invite a member to say his name accompanied by a short bodily movement. The whole group must then repeat that name together with that movement. Repeat for all members.

Step 3: Invite a member to say her name with her corresponding movement, followed by her saying someone else's name and making that person's movement. That person takes over, repeats their own, and "sends" the game to a further member, and so on.

A more advanced version, for the higher grade levels, includes movements only (without names), increasing the need for memory and concentration.

### Counting Game

Simple mathematics during which pupils sit in groups of two, facing each other, and must count to 3 together. Pupils A starts with 1, B continues with 2, A says 3, B says 1 and so on....The pupils are challenged to keep a steady rhythmical pulse. When they are well-rehearsed in this task, introduce a clap instead of the number 2. When the pupils have become comfortable with this stage, introduce a whistle instead of the number 3. Whistling while you laugh may not be so easy...

### Movement Exercise (1) - "Friends!"

Step 1: Ask your pupils to move around freely in the room.

Step 2: While they are walking, ask each one to choose a "friend" in the room (but make sure they do not tell anyone who their "friend" is).

Step 3: While they are still walking, ask each one to choose an "enemy" in the room (but make sure they do not tell anyone who their "enemy" is).

Step 4: Ask your pupils to now make sure that their "friend" is between them and their "enemy", so as to "protect" them (make sure they understand that this should happen while they are still moving). It may take pupils 10-15 seconds to understand how the exercise works, but when they do, the result may be quite comical! Allow them to enjoy this for 30-40 seconds before starting another round. Repeat 2-3 times.

### Movement Exercise (2) - "Lobsters!"

In this exercise, two of the pupils are assigned to be "lobsters", while all others are "humans". The "lobsters", walking on all fours (facing up), must touch one of the "humans", who then becomes a "lobster". The "lobsters'" goal is to turn everyone in the room into "lobsters". The last "human" in the room is the winner.



*Note: Make sure there is ample space for movement, and that there are no loose objects which may fall off tables or shelves during this game (computers, expensive phones, etc.), as this game may be quite active!*

### **Movement Exercise (3) – “Hand on Red!”**

In this exercise, call out a body part, and then a color on which pupils must place that body part. For example: Call out “Hand on Red!” after which pupils must place their hand on anything red in the room. The last pupil to have placed their hand on something red must call out the next round. Examples: “Foot on Green!”, “Ear on White!”, and so on. This game can go on for 3-4 minutes. *Teacher’s Tips: Make sure there is nothing dangerous in the room, especially when working with very young children (glass bottles, etc.).*



### **7 Assessment**

During your training workshop for teachers, you will be asked to assess the workshop. Please refer to the CREATIONS project website in order to learn more about assessment structures for pupils.

In assessing the WASO workshop / activities, it is important to consider the scientific content, the artistic content, as well as the creative environment of the activity as it emerges at the meeting point of science and art, with regard to the CREATIONS pedagogical principles (see CREATIONS D2.1).



**8 Possible Extension**

WASO may be implemented during a complete school year, and in more than one class in a school.



### **9 References**

Chappell et al (2016). D2.1 CREATIONS Features of Inquiry. CREATIONS - Developing an Engaging Science Classroom, H2929-SEAC-2014-1 CSA, 665917.

Ben-Horin, O. (2014). D3.1 The WASO Guidelines: CREAT-IT project. Available at: <http://www.opendiscoveryspace.eu/edu-object/write-science-opera-waso-guidelines-820499>

CREAT-IT (2015). Project website. [www.creatit-project.eu](http://www.creatit-project.eu)

