



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

**WASO Implementation Scenario: “Sounds of Science”, a
Science Opera**

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1: Introduction

The following Write a Science Opera (WASO) Implementation Scenario should be read together with the WASO Guidelines, which provide a detailed plan for the realization of a Creative Arts-Infused Inquiry-Based Science Teaching project within the WASO Case Study. These include warm-ups, a conceptualization of the cross-disciplinary project as Inquiry-Based Science Education, exercises in music, drama, costume-making, schedules for the project, evaluation, reflection and more.

Specific suggestions for meeting points between the science learning and the opera development are made throughout this scenario, yet this document is conceived as a “living document”, and teachers of each unique WASO project are free to design the schedule and creative exercises according to their needs and capacities.

Several *Teacher's Tips* are provided in this document. These tips suggest enhancements and optional activities, and are provided by teachers who have previously conducted WASO projects in their classes.

This Implementation Scenario is designed as a 1-week project, during which the first day may be preparatory (only 1-2 hours are dedicated to the project), while the entire rest of the week should be dedicated to the project. *Note: In the WASO Guidelines, you will find suggestions for how to realize a longer, more detailed, project if desired.*

2: Educational Challenges

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

2.1 Exploring the Science of Sound

Reasoning for choice of approach: The scientific characteristics of sound provide grounds for exploration which can be directly incorporated in the opera's orchestra. In this Implementation Scenario, the sound-making devices are simultaneously instruments of inquiry as well as the actual orchestra.

2.2 Exploring Creative Approaches in Science and Art Education

Reasoning for choice of approach: The Implementation Scenario offers an inherently creative design which stimulates creativity in the IBSE setting. Bridging arts and science approaches means focusing on 'inquiry' in itself as well as 'inquiry' as a basic requirement in creativity and in different creative practices.



3: Scenario Characteristics and Needs of Students

The scenario will be an opportunity for students to explore issues related to Sound and its scientific qualities, including movement of air and impacts of various physical parameters such as speed and size on audible results such as pitch and timbre.

The approach is more direct than school textbooks, as pupils must directly engage with the material, acquire knowledge, make choices and reflect upon these before the opera may be completed.

The exercise will also allow students to interact (e.g. by working in pairs) and develop social and collaboration skills, thus experiencing how science can be a group activity and not only a solitary one: Individual, collaborative and communal activities for change.

Pupils will be introduced to the common creative impulses of science and the arts.

4: Rationale of the Educational Approach

The scenario is designed as a transversal meeting point between the Write an Science Opera (WASO) methodology and an Inquiry-Based science education model. It follows a scientific approach while opening doors to experiencing new possibilities on several levels. As part of the exploration towards the school opera's creation, students are asked to explore Sound, supported by indicative questions, all of which will infuse and inspire the opera's creation: The opera's design, libretto, characters, costumes, and music all represent potential ways of interpreting the students' inquiries. Based on those inquiries, the students are asked to come up with their own conclusions and compare them to their initial predictions. They thus engage in Possibility Thinking (PT) regarding how the creative artistic process can act as a base for deeper inquiry as well as an aesthetic medium of communication of the various hypotheses and evidence-based conclusions. The complete activity, within both science and art, is based on students' creation and observing skills.

Students have the opportunity to explore the "Sounds of Science" within hands-on exploratory science activities at the same time that they are experiencing a similar hands-on process with musical instruments, costume creation, lighting, performance, etc. creating a deep understanding of the importance of materials within both disciplinary areas.



5: Learning activities

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

Phase 1: Question Eliciting Activities/Exhibiting Curiosity

Phase 2: Active Investigation

Phase 3: Creation

Phase 4: Discussion

Phase 5: Reflection

In the following table, specific WASO activities are based on the CREAT-IT Pedagogical Principles and an understanding of Inquiry Based Science Education, as described in the CREAT-IT Pedagogical Framework (see "Recommended Literature" for further details).



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Science unit topic	Materials and Resources
<p>Sound (UK Primary School Year 4)</p> <p>Class information</p> <p>Year Group: 4th grade</p> <p>Age range: 9-10</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><i>What do you need?</i> Various music instruments (bass drum, snare drum and steel pan, each with a cup of rice; bottles and colored water in a jug; trays, jugs, water and tuning forks; wind instruments; hollow tubes of different lengths; frog guiro), large paper, marker pens, materials for making costumes. Optional: Stage, lights</p> <p><i>Where will the learning take place? On site or off site? In several spaces? (e.g. science laboratory, drama space etc), or one?</i> Learning can take place in school (regular class or music room) or at science education center/science museum. It is a good approach to have several rooms available during the phase where pupils are split into groups (see WASO Guidelines)</p> <p><i>Health and Safety implications?</i> In the case of sewing of 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 (searching for information).</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 the specific area of Sound is required. Pupils can use this scenario in order to explore basic concepts in the field.</p> <p>An understanding of the basic 4th grade learning plan in science (e.g. asking relevant questions and using different types of scientific enquiries to answer them, setting up simple practical enquiries, making systematic and careful observations) is needed.</p> <p>Optional: music lessons including composition exercises; basic drama exercises; dance; arts & crafts classes; experience with school stage performances is an advantage</p>	
<p>Individual session project objectives (<i>What do you want pupils to know and understand by the end of the lesson?</i>). <i>Note: A detailed plan for these sessions are provided below.</i></p> <p>During this scenario, students will</p> <p>Day 1): find patterns between the pitch of a sound and features of the object that produced it; Experience musical, visual design, drama techniques as tools for the opera.</p> <p><i>Note: Teachers may decide the science opera's theme specific 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 will 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</i></p>	



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questions connected to the chosen theme. In the case of the current scenario, the theme has been based on the activity described by teacher "Louise" in the Creative Little Scientists EU FP7 project¹.

Days 2-3): 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 Sound. 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.

Note: A large-scale opera project is usually not feasible during a 1-week project. Aim for a short, 8-10 minute long opera performance with simple costumes and scenography.

Days 4-5): The student should be able to describe several fundamental concepts concerning the nature of a sound wave, including identification and description of characteristics or properties of sound such as intensity, frequency. Students will learn to realize common impulses between discipline knowledge in both science and arts by performing a multi-disciplinary artistic performance (school opera) which demonstrates and deepens scientific and emotional understanding of the Sounds of Science. 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.

Assessment	Differentiation	Key Concepts and Terminology
<p>The WASO Guidelines' Appendix 1 provides an evaluation plan for students who took part in the WASO project. This questionnaire includes questions about their level of enjoyment, level of difficulty, comparisons to more traditional teaching methods, etc.</p> <p>How will you record this? Questionnaires will be filled out by pupils and collectively delivered to the CREAT-IT team.</p>	<p><i>How can the activities be adapted to the needs of individual pupils?</i></p> <p>Some pupils have had more training in arts disciplines (e.g. music, drama, costume-making). These pupils may be encouraged to do more advanced work. Examples: A pupil who has had piano lessons may be encouraged to compose an extra aria for the Science Opera; a pupil with good stage presence may be asked to assist the other performers in learning how to express the section(s) of the libretto which they will be performing.</p> <p>The creative process is in itself inclusive of all pupils. The more pupil voices there are with different thoughts and viewpoints (independent of level of</p>	<p>Science terminology:</p> <p>Sound, Sound travel, Pitch, Intensity, Frequency, vibration, pressure/displacement, sound waves, speed of sound, sound intensity, sound pressure, timbre/tone, loudness, decibel scale, noise, audio equipment, systematic observations.</p> <p>Arts terminology:</p> <p>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.</p> <p>2) Duet: Two singers, preferably each singing their own verse followed by a section in which they sing together.</p> <p>3) Ensembles: Three or more singers</p>

¹ <http://www.creative-little-scientists.eu/>



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	<p>understanding) greater the pool of ideas will be with more input to the opera's story.</p>	<p>4) Choir: The choir can be used to "comment" during the other songs, or as simple choir pieces.</p> <p>5) Overture: Instrumental (no voices) opening piece which sets the mood of the opera.</p> <p>6) Interlude: Music performed between acts or scenes.</p> <p>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.).</p> <p>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</p> <p>9) Various musical instruments</p>
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During this scenario, students will

- Create a multi-disciplinary artistic performance (school opera) which demonstrates and deepens scientific and emotional understanding of Sound, supporting discipline knowledge in both the science and arts educational disciplines.
- Learn basic concepts about the functioning of sound.

IBSE Activity	Potential arts activity	Student	Teacher	CREAT-IT Pedagogical Principles
Phase 1: Question Eliciting Activities	<p>Explore the various instruments.</p> <p>Begin cooperation with artists or the music/fine arts/drama/dance teacher at your school in order to generate ideas</p> <p>Discuss with your students the idea of creating a multi-disciplinary performance designed and inspired by a scientific theme.</p> <p>Define opera's theme based on scientific knowledge</p>	<p>Generate and write down words/ideas about Sound, and shares with others in order to learn from their previous knowledge</p>	<p>Activates previous knowledge in the fields of scientific exploration, and, by inviting students to experiment with the various musical instruments, motivates them to raise questions they are wondering about based on these:</p> <p>The tables are set up with equipment for exploration: bass drum, snare drum and steel pan, each with a cup of rice; bottles and colored water in a jug; trays, jugs, water and tuning forks; wind instruments; hollow tubes of different lengths; frog guiro. All tables have large paper and felt tip marker pens. Students have 30 minutes to explore the resources on two tables and then find a way to represent on paper how sound is made.</p> <p><i>Teacher's Tip:</i></p> <p><i>The adults are there to help but only if asked. You have to decide how the things on the table will show you how sound travels.</i></p>	<p><i>Professional wisdom is respected and encouraged:</i> It is vital that CREAT-It has, at its heart, the wealth of teaching and discipline knowledge and expertise that practitioners bring to the project.</p> <p>The following are the CREAT-IT Pedagogical Principles which are realized:</p> <ol style="list-style-type: none"> 1. Individual, collaborative and communal activities for change 2. Risk, immersion and play 3. Dialogue 4. Interrelationship of different ways of thinking and knowing 5. Discipline knowledge 6. Possibilities 7. Ethics and trusteeship 8. Empowerment and agency



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Phase 2: Active Investigation

Propose opera characters representing various entities in the learning process (e.g. specific instruments, the aural system, air), etc.

Divide students into groups (orchestra/composers, librettists, stage design, opera chief, Public Relations, etc.).

Explore representing the chosen scientific learning theme as a dramatic storyline.

Explores the preliminary questions proposed by the students, defines ones to work with, and collects information aimed at responding.

Teacher's Tip: Some children used the resources as the teacher expected, such as putting rice on the drums, but others used them in unexpected ways, such as using the rice cups as maracas.

Leads a discussion based on the following questions: What do you want to find out about these questions? What are your predictions regarding these?

Phase 3: Creation

Main activity of opera creation and rehearsals, on all levels (costumes, music, staging, libretto, etc.).

Students add different amounts of water to the bottles and discuss the impact when they clink them together.

Leads a discussion based on the following questions: What is a science opera? How can you represent scientific concepts through arts? What do you observe in the way your knowledge is learned? What are the scientific key concepts related to Sound?

Teacher defines central key concepts to be included in the process.

Asks following questions: What do you expect to learn about the scientific themes? How would you explain the way you are learning? What is expected/ unexpected in this way of learning?



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<p>Phase 4: Discussion</p>	<p>Discussion of any challenges that arise as part of the working process, including questions such as: Which concepts should be included in the libretto?</p> <p>Therefore, the discussion and creation phase will necessarily be entangled.</p>	<p>Prepare their results for discussion.</p> <p>Perform the Science Opera.</p>	<p><u>Helps students evaluate</u> results.</p> <p><u>Leads a discussion</u> about vibration and pitch, and what their explorations mean for other musical instruments, for example the flute.</p> <p><u>Asks</u> the following questions: Which are these the point about Sound that we want to communicate? What information would you use to support your view? What remains unclear?</p>
<p>Phase 5: Reflection</p>	<p>Discuss various specific and focused issues (stage design, libretto, PR activity, group dialogue, ethical decision-making regarding inclusion of all students in the creative process, etc.).</p>	<p>Upload results (recordings, assessment) to the CREAT-IT portal (portal.creatit-project.eu) with the help of the teacher.</p>	<p><u>Creates an overview</u> of what has been discussed in the classroom during the project. You may focus on challenges which arose during the process or why various images were chosen as activity foci.</p> <p><u>Teacher leads a discussion</u> including the following IBSE questions: Has your thinking changed through exploring sound by working in this way? What new question could you ask?</p> <p><u>The teacher guides</u> the student to further open-ended study</p> <p><u>The teacher invites</u> students to reflect on the resemblances and differences of creating art and science.</p>



6: Performing the Opera – Additional Information

6.1: Students

The maximum recommended group size for each WASO project is 25-30 divided into 6-7 groups of various functions, as described in the WASO guidelines. *Teacher's tip: additional students in other musical, visual arts, dance classes may take part in the final performance event by providing a warm-up act to the opera, for example. This engages the WASO class in a dialogue with a wider circle of pupils in the school.*

Students perform scientific prediction and realize creative, arts-infused case study scenario: Recording observations; Performing prediction compared to results; Developing experimental models; Participating in creative case study scenario (WASO).

Students as Group Participants: Use or evaluate a technique; Use science to explain.

6.2: Project instructors

External opera artists and scientists in collaboration with art, music and science teachers from the school. *Note: the number of external artists and scientists in each unique project will depend on various parameters such as budget, availability, length of project, available volunteering professionals, number of school teachers assigned to the WASO project, number of students involved, etc.*

Teacher: Presents ideas and evidence in science; Asks questions; Identifies misconceptions; Applies scientific methods; Develops experimental models; Provides historical and contemporary examples

School leadership: considering the nature of the WASO project, with regard to the need to orchestrate teachers and professionals from various fields, it is crucial that the school's leadership is involved in the project's planning, realization and evaluation. This is true due to the need for the WASO project to accommodate each unique school's schedule, specializations, students of special needs, geographical location, rooms, etc.