

**Atoms & Molecules at Rubbestadneset**

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The Demonstrator describes and plans CREATIONS implementation at Rubbestadneset School in the Bømlo Municipality in the South-Hordaland region of Norway. The implementation's theme will be "Atoms & Molecules", and corresponds to the Norwegian curriculum for the 8-9<sup>th</sup> grades. The methodology employed relies on some elements of the Learning Science Through Theater (LSTT) and Write a Science Opera (WASO) teaching approaches. Pupils will take part in a week-long intervention that will include workshops, a performance and evaluations.



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### 1 Introduction / Demonstrator Identity

#### 1.1 Subject Domain

Subject domain for science is “Atoms & Molecules”, based on the Norwegian curriculum for science for the relevant age groups. Specifically, the intervention relates to the Norwegian Competence Aims<sup>1</sup> following Grade 10, “Phenomena and substances». Furthermore, arts subjects include visual arts, music, drama, lighting and design.

#### 1.2 Type of Activity

Type of activity is a creative teaching approach to inquiry-based science and art education in which pupils of different ages, supported by teachers, artists and scientists, take part in a creative process and are thereafter the creators of an educational performance.



Rehearsals at Rubbestadneset School (Picture courtesy of [www.bomlonytt.no](http://www.bomlonytt.no))

#### 1.3 Duration

This demonstrator describes a 1-week (5-day) workshop at Rubbestadneset School<sup>2</sup>, whereby day 1 is dedicated to preparations and pre-evaluation of pupils, days 2-4 are dedicated to the creative process and performance, and day 5 is dedicated to summary, post-evaluation and planning future collaboration where possible.

<sup>1</sup> <https://www.udir.no/kl06/NAT1-03/Hele/Kompetansemaal/competence-aims-after-year-level-10?lplang=eng>

<sup>2</sup> <https://www.bomlo.kommune.no/tenester/skule-og-oppvekst/rubbestadneset-skule/>



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

The intervention will take place in formal schooling. The head-teacher has allowed the 8<sup>th</sup>-9<sup>th</sup> grade classes to dedicate their time solely to the CREATIONS implementation during this week. On the last day of implementation, the resulting “Atoms and Molecules” performance will be performed for the entire school.

### 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

A Write a Science Opera (WASO) training will take place with several teachers from the single school in order to prepare them for the scenario. 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.): a non-typical classroom situation based on a “workshop” atmosphere, and in which unexpected questions and situations may arise, as pupils take charge of the learning process and the communication of that learning.

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

#### *2.1 Challenge*

The approach 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.

#### *2.2 Added Value*

The approach provides learning opportunities in which pupils may cross-inspire and learn from and with each other in a creative school environment. To this end, CREATIONS offers the teachers an inspirational workshop before the implementation with pupils. Teachers will thus learn 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 Atoms & Molecules, and specifically, elements Na, Cl, H, O, and interactions between them as molecules.

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, pupils will:

- Finalize and perform a multi-disciplinary artistic performance (school opera).
- Engage in activities which inspire curiosity around Atoms & Molecules; Explore musical, visual design, drama techniques as tools for the opera. *Note: Teachers may decide the science opera's specific topic within the larger theme (e.g. the water molecule) before the project or allow pupils to choose the scientific topic themselves. Each approach has its advantages: In the case in which the teacher chooses the specific topic 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.*
- Gain knowledge and experience with group-work in which various groups will create specific synopsis, libretto, composition, scenography, costumes for the intervention, accompanied by a continued exploration of Atoms & Molecules. *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



- Familiarization with interconnection of science with aspects of art (supporting discipline knowledge in both the science and arts educational disciplines).
- Developing a spirit of cooperation and teamwork



### 4 Demonstrator characteristics and Needs of Students

#### 4.1 Aim of the demonstrator

The aim of the demonstrator is to describe, support and document the implementation of CREATIONS project at Rubbestadneset school.



CREATIONS at Rubbestadneset, Bømlo (Norway)

#### 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**

The general approach is adaptable to the specific school's time schedules, priorities, etc. In the case of the current intervention, CREATIONS team and the school teachers met to discuss and plan the implementation and decided upon the 1-week plan mentioned above. The pupils (25 in total) will simulate an "opera company" in which performers, composers, designers, scenographers, science educators, etc., collaborate to create a performed artwork. There is no "one size fits all" approach to the activity and the CREATIONS trainers expect to see emerging content during the project implementation.

The following is required during implementation:

1. 2 classroom spaces
2. Musical instruments
3. Raw material for costumes and scenography
4. Stage
5. Audio equipment for performance
6. Musical instruments

The table below provides an outline for a 1-week workshop. Each phase (of 7 phases) will, during this training, last for several hours.

<p>Science topic: Atoms &amp; Molecules</p> <p>Class information</p> <p>Year Group: 8-9</p> <p>Age range: 13-14</p> <p>Sex: both</p> <p>Pupil Ability: General public school. 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><i>Where will the learning take place?</i> Learning and corresponding performance will take place at Rubbestadneset School.</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).</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 is required for pupils, except successful completion of the standard Norwegian curriculum of the relevant age group. No prior knowledge regarding the arts is needed for pupils. The approach caters to all pupils, and includes exercises in e.g. music composition which allow novices to compose simple sections of the opera. The CREATIONS implementation team will, however, be flexible and interested to include any additional extra-curricular activities which pupils may be interested in. Pupils with special knowledge in e.g. piano playing, dance, etc., will be able to find space during the project to make use of these interests and talents.</p>		
<p>Assessment</p> <p>Assessment will be done in the form of online evaluation (pre- and post) completed by pupils online. Teachers</p>	<p><b>Differentiation</b></p> <p><i>How can the activities be adapted to the needs of individual pupils?</i></p>	<p><b>Key Concepts and Terminology</b></p> <p><b>Science terminology:</b></p>



<p>will also complete evaluation forms online. All questionnaires have been translated into Norwegian.</p>	<p>The approach allows adaptation to various interests and needs of different pupils. This is true for both science and the arts.</p> <p>Examples (science): Pupils who require extra focus on a challenging point in the curriculum may be supported as the intervention exercises great flexibility regarding the design of its implementation.</p> <p>Examples (arts): choice of tonality, level of rhythmical complexity of songs, etc.</p>	<p>Atoms, Molecules, Elements, Periodic Table, Electrons, Protons</p> <p><b>Arts terminology:</b></p> <ol style="list-style-type: none"> <li>1) 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</li> <li>2) Various musical instruments</li> <li>3) Scenography – the visual settings and design of the stage</li> </ol>
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### Session Objectives:

During this scenario, students will: Explore a specific topic within the theme of Atoms & Molecules; Experience musical, visual design, drama techniques as tools for the performance. Students will gain knowledge and experience with group-work. The “opera libretto” will 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></p>	<p>Generate and writes down words/ideas about Atoms and Molecules, and shares with others. <i>Note: It is highly recommended to include a hands-on scientific experiment at this phase in order to elicit questions.</i></p>	<p>Activates previous knowledge in the fields of scientific exploration, and introduces</p>	<p>Experiment with various musical instruments and drama techniques. This should be</p>



	and 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.		scientific knowledge about the topic, mainly in the form of inquiry-based questions.	done in the form of question, such as “how can we communicate the structure of the water molecule through drama?”
<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.	Guide students to relevant evidence.	Comparing artistic ideas to other art-works, 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.)



<p><b>Phase 4:</b> <b>EXPLAIN:</b> students formulate an explanation based on evidence</p>	<p>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.</p>	<p>Formulations of scientific explanations for what they have discovered and learned.</p>	<p>Guide students in their consideration of possibilities.</p>	<p>Continued production of original material (music, etc.), and opera rehearsals.</p>
<p><b>Phase 5:</b> <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> <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. Example of communication through the Bømlo Municipality website: <a href="https://www.bomlo.kommune.no/tenester/skule-og-oppvekst/rubbestadneset-skule/eit-spennande-og-kreativt-prosjekt-i-naturfag-med-elevane-pa-8-og-9-trinn.226095.aspx">https://www.bomlo.kommune.no/tenester/skule-og-oppvekst/rubbestadneset-skule/eit-spennande-og-kreativt-prosjekt-i-naturfag-med-elevane-pa-8-og-9-trinn.226095.aspx</a></p>	<p>Supports the communication process and the performance logistics</p>	<p>Opera performance: It is advised to invite community (parents, other teachers, etc.), and to include a short scientific 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>Lead the reflection process and ask relevant questions which relate to <i>change</i>.</p>	<p>Reflection on the process, and collection of documentation of data to the extent possible / sharing experiences via social media.</p>
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### 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

CREATIONS implementations are assessed by both pupils and teachers. Evaluation analytics will show the effectiveness and efficiency of employing creative teaching approaches. The web analysis will be used to show a change in the users-behaviour. The evaluation approach of the CREATIONS project will use both qualitative and quantitative approaches. The umbrella question is: *can the implementation of the CREATIONS features influence science motivation, or motivation for pursuing science respectively?*

Further details:

- Teachers fill out a short questionnaire (VALNET) regarding the impact of CREATIONS activities on the curricula. This will support the connection of CREATIONS with different schools and policy makers. In Norwegian, the link to this questionnaire is:
- Pupils fill out questionnaire pre- and post intervention (Science Motivation Questionnaire (SMQ)). For Norwegian the link is: [https://docs.google.com/forms/d/115pUgFmFn-1oUqkhdauxnC4jAKv\\_6lIMOjgwO2YKAdM/viewform?ts=58174c17&edit\\_requested=true](https://docs.google.com/forms/d/115pUgFmFn-1oUqkhdauxnC4jAKv_6lIMOjgwO2YKAdM/viewform?ts=58174c17&edit_requested=true)



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