Telling the world what we are learning

Secondary: (ages 11 – 14)	Interdisciplinary (e.g. chemistry)

The activity can be carried out in any subject, but what is described below has been prepared for chemistry. The activity takes place in two stages. Students first decide how to communicate what they are learning with the rest of the world. Students brainstorm and together select three or four projects. Students may have many good ideas: blogs, plays, board games, radio programmes, journals, songs, videos, etc. In this example the class wanted to create a blog, a radio programme, and a board game about chemistry. Students then put their ideas into practice by enquiring into and investigating aspects of daily life related to the subject in order to create their outputs.

Time allocation	7-8 lesson periods
Subject content	This activity can be used to articulate, deepen, and communicate learning that is taking place in **any area of the curriculum**.
Creative and critical thinking	This unit has a **creativity** and **critical thinking** focus: • Produce a meaningful output that expresses subject learning • Learn how to foster creativity and critical thinking in, for example, science
Other skills	Collaboration, Communication, Persistence/Perseverance
Key words	chemistry; project; communication; scientific method; creativity; critical thinking

Products and processes to assess

Students may come up with a multitude of imaginative products to represent their subject knowledge. They should evidence the ability to generate and play with ideas, see connections, and think in a divergent manner to approach their subject knowledge from different perspectives and relate it to everyday life through their creative output. Assessment can also focus on the way they put their project into practice and on the extent to which their outputs are original, engaging, personal, and represent successful applications and articulations of subject knowledge.

Teaching and Learning plan

This plan suggests potential steps for implementing the activity. Teachers can introduce as many modifications as they see fit to adapt the activity to their teaching context.

Step	Duration	Teacher and student roles	Subject content	Creativity and critical thinking
1	Lesson period 2 together with variable work time at home	Students are asked to explain what they understand about the concepts of creativity and critical thinking and their importance in, for example, science. Teacher guides the contributions towards an explanation of what creativity is, why it is important and how to develop it. Teacher can briefly introduce different levels of intellectual work of Bloom's taxonomy for the students to analyse on what level they work on in each activity and subject. Next, the teacher asks students to create their own mental maps of the units they have studied to date in the relevant subject (e.g. chemistry units).	Reflecting on the relationship between subject and critical and creative thinking Representing their subject learning to date and using mental maps	Understanding the role of creativity and critical thinking in developing subject knowledge
2	Lesson period 2	The video "7 steps of creative thinking" by Raphael Diluzio is shown, in which the artist makes reference to the 7 mental steps in the creative process according to the studies of the physicists K.C. Cole and Murray Gell-Mann (Creativity at the Crossroads of Art and Science: a Dialogue) - (See resources). After, the teacher facilitates a discussion on the most important aspects of the video, the seven steps and the importance of each step in, for example, scientific experiments and investigations. The students write a brief explanation of each one: 1. Pose a question or brainstorm about what we can or want to create. 2. Find information or investigate the question. 3. Recognise the time to stop searching for information to continue with our process. 4. Think about our question from points of view which have nothing to do with our question (lateral and divergent thinking). 5. The "eureka moment" where something truly innovative and original occurs to us which answers our question and should be noted down by us immediately. 6. Pooling of ideas with the group/listening to opinions.	Learning about the scientific method	Questioning their own assumptions about how we learn and create knowledge (e.g. reflecting on creativity in the scientific method) Learning about how to foster creativity in subject knowledge (e.g. in scientific thinking)
3	Lesson period 3	Teacher asks for ideas for what we can create to disseminate or reveal what we have been learning in the subject (the teacher can choose to focus this on a particular area of the curriculum or give students freedom to cover any area they have learned about). On the basis of this question a brainstorming session develops in which the students write down ideas, and are encouraged to be as original and creative as they can. Padlet, an	Articulating currently existing subject knowledge and understanding the importance of distributing knowledge	Making connections between subject knowledge and creative ways to represent that knowledge Generating multiple ideas for

		online bulletin board can be used here so that students can see everyone's ideas. Examples: composing a song about the periodic table, putting together a show with the most important chemists as characters, games, journals, costumes, radio programmes and much more. Students select the projects that are most inspirational for them. For example, - Creating a journal/online blog online on chemistry - Recording a radio programme on chemistry - Designing a question and answer game about chemistry The students may be inspired to see that, although initially nothing came to mind, at the end of the session interesting and original ideas flowed freely. Note: If, for example, the journal/online blog is chosen, every student can commit to writing an interesting article in which they apply the content studied. To create the article the students apply the seven steps of the creative process previously mentioned. It is useful to know and/or limit the different privacy and accessibility options available for any blog created and this can also be used as an opportunity to educate students about digital literacy and online safety.	Creating links between subject knowledge, communication, and pre-existing areas of interest for students	meaningful and creative outputs
4	Lesson period 4 and variable work time at home	After a period of home-based research and brainstorming, the students begin to create their output. These may be highly original ideas which include much subject content. Examples of articles that students have previously come up with include: "Helium and a funny voice", "A clean house thanks to natural chemical compounds", "Love and Chemistry", "Radioactivity", "Mercury and Intelligence", etc. Some articles may require some degree of editing and students may need support to re-write or amend their output various times to improve quality.	Researching the subject and using subject knowledge to produce something that successfully communicates and articulates their learning	Producing a meaningful output that allows them to apply and express their subject knowledge in a creative way
5	Lesson period 5	Students assess the activity, analyse which aspects of their output relate directly to the subject, reflect on how their creative process has been, how ideas came to them, what they have learnt from it, etc. Then, they prepare to organise a talk for the students in the year below where they will explain the importance of creativity and critical thinking, introduce their project, what they have learnt, what has been created, and the advice they could give now they know slightly more about creativity and critical thinking.	Communicating the method they have used to represent their subject knowledge to other students	Appraising their output and reflecting on its novelty and other strengths and weaknesses Producing a meaningful presentation that reflects on the role of creativity/critical thinking in developing subject knowledge
6	Lesson period 6	General talk rehearsal	Reviewing and improving their talk	
7	Lesson period 7	The students give the talk on creativity and critical thinking to the year below.		Expressing how they have used creative/critical thought
8	Lesson period 8	The students consider how to proceed with the rest of the projects (e.g. radio programme, chemistry board game). Also, they are asked to make small changes as necessary in order to improve their outputs.	Reviewing and planning other methods to communicate subject knowledge	Reflecting on steps taken to create output and where to go next

Resources and examples for inspiration

Web and print

- Seven Steps of Creative Thinking. https://www.youtube.com/watch?v=MRD-4Tz60KE
- Padlet (online bulletin board)
- Resources from the web page www.mindtools.com

Other

- Big screen and computer to project the video.
- Computers with internet access for the information search and the writing and design of articles and the journal or other outputs
- Students may require additional resources depending on what project they select. This will need to be assessed and carefully managed.

Opportunities to adapt, extend, and enrich

- A cross-disciplinary approach could be taken with links made to, for example, art and design for the illustration and layout of articles, graphic design of the blog, etc. or the project could have a wider scope, with students being asked to come up with creative outputs to communicate and connect what they have learned in multiple subjects

Creativity and critical thinking rubric for science

- Mapping of the different steps of the lesson plan against the OECD rubric to identify the creative and/or critical thinking skills the different parts of the lesson aim to develop

	CREATIVITY Coming up with new ideas and solutions	Steps	CRITICAL THINKING Questioning and evaluating ideas and solutions	Steps
INQUIRING	Make connections to other scientific concepts or conceptual ideas in other disciplines	1,3	Identify and question assumptions and generally accepted ideas of a scientific explanation or approach to a problem	2
IMAGINING	Generate and play with unusual and radical ideas when approaching or solving a scientific problem	3	Consider several perspectives on a scientific problem	2
DOING	Pose and propose how to solve a scientific problem in a personally novel way	4,5,7	Explain both strengths and limitations of a scientific solution based on logical and possibly other criteria (practical, ethical, etc.)	2,5
REFLECTING	Reflect on steps taken to pose and solve a scientific problem	5,7,8	Reflect on the chosen scientific approach or solution relative to possible alternatives	5,6

Appendix

The objectives break down into three sections

1. **For students to learn the basic content of chemistry, which is detailed below:**
   Science and scientific method
   How do you carry out research?
   What is and what is not science?
   The physical states of matter
   Molecular kinetic theory
   Changes of state
   Distinctive properties of substances
   Density
   The gas law
   Homogenous and heterogeneous matter
   Pure substances
   Solutions
   Suspensions and colloids
   Separation of substances
   The chemical elements
   The structure of matter
   Ions and ionic compounds
   Chemical formulae
   Physical and chemical phenomena. Chemical reactions
   Applications of chemistry
2. **For students to familiarise themselves with the basic processes related to creativity and critical thinking**
   Approach to the creative process:
   Bloom's taxonomy
   Mind maps
   Brainstorming
   Other mind tools

3. **For students to develop their own creative process based on some basic common guidelines:**

Students create their mind maps relating to the content mentioned above.
Using a brainstorming session, they propose ideas to carry out a project in class. In order to “come up with ideas” they use some of the tools analysed previously. Together they select the best and put them into practice. Specifically, they choose the project to create a scientific journal on chemistry. Each student produces their article.