

**CoRe: Content Representation Tool
(Loughran, Mulhall, & Berry, 2004)**

Big Ideas/Concept:	Creativity is essential to all stages of scientific investigation (asking a question, designing investigations, interpreting data, etc.) Level: high school
1. What you intend students to learn about this idea	Science is a human activity which requires imagination and creativity in all of its stages. There is not an only way to do scientific investigation, and also there is no universal step-by-step in scientific method. Using creativity along with scientific investigation is a good idea to present for science students because it can improve students' scientific skills in thinking; students will gain a much benefit in learning rather than just follow steps from a cookbook. Creativity should be involved in every step of an experiment or scientific investigation (setting question, designing approach to solve a hypothesis, collecting data, interpreting data, and presenting a conclusion).
2. Why is it important for students to know this	<p>Creativity encourages students to have their own ideas; it is a good way to improve students' scientific skills. Creativity causes various inventions to happen. Normally, each people have different prior knowledge. Thus, it is ordinary that they will interpret data in different ways although using the same set of data. Creativity also improves science approach being more interesting not just being a cut-and-dry procedure like following every stage from a cookbook.</p> <p>Using a science history along with science content would be a good way to give students a concrete example about human endeavor to create science invention. From studying a story of a famous scientist, students will get a point that to discover scientific knowledge, it was not easy. The old belief in the past always changes when the new idea is created. Although discussing in the same topic, each scientists thinks in the different way because each has their own creative idea to think their own ways figure out problems, leading to advance in science that we can see nowadays. Driver (1996) also states about creativity in the aspect of the epistemology of scientific knowledge that teachers should encourage students to think about "how things are" rather that "what things are" because students will not improve any creative idea if they consume just the result instead absorb others' idea (learn from a story of famous scientists) to be a guideline and practice to think in their own way.</p>

<p>3. What else you know about this idea (that you do not intend students to know yet).</p>	<p>The idea of using creativity in a science classroom is related to Feyerabend's idea. While Kuhn focuses on theory or paradigm, Feyerabend rejected any reliance on a scientific method; rather, he claimed ironically that if one is keen to have a universally valid methodological rule, anything goes would not occur. He promotes "anarchistic" of science which is the way to support freedom of thinking for scientists stated that scientists' ideas should not be constrained from methods (Chalmers, 1999). I think Feyerabend's perspective is quiet interesting in term of encouraging people to believe on their own ideas and trying to use creativity being a part with their works rather than just relying on scientific method; this can diminish people fear and encourage them daring to open-mind to create new things.</p>
<p>4. Difficulties/limitations connected with teaching this idea</p>	<ol style="list-style-type: none"> 1. Time is limitation of teaching this idea because creativity is to promote thinking skill. Good idea might not occur in limited time; thus, it is difficult for teacher to control time when using creativity activity in science classroom. 2. Lacking a good prior knowledge is a barrier for students with this idea method. If students do not have enough science background knowledge, it is difficult for them to enjoy learning and to create their own ideas. 3. Lacking a good prior knowledge is also a problem for teacher to manage creative activity or create lesson study in science classroom. If a teacher does not have well scientific knowledge or the nature of science, he can not predict a result of activity that he expects students to learn, and cannot help improving students' creative skill. Therefore, it is difficult to push students reaching a goal when the instructor lacks of background knowledge.
<p>5. Knowledge about students' thinking which influences your teaching of this idea</p>	<p>Many students have a misunderstanding that "Science is procedural more than creative" (McComas, 1996, p. 8). This is a big barrier to succeed in this idea. A cause of this idea might come from an old traditional teaching that teachers always tell every step to students. Students' responsibility is just to follow teachers' direction or a procedure from a cookbook. This idea is still in students' mind. Hence, students do not try to think about a solution to fix a problem by themselves. That is very bad for them because if they have not tried to create their own ideas, how can their scientific skills improve. Teachers are important persons who can help students to push their creativity into their investigation. Teachers might design their lessons or laboratories that focus on</p>

	<p>encouraging students to use creativity. For instance, let students to setting question for the experiment, and let them try to create their own way to solve a problem. Teacher's responsibility should be a mentor not just a lecturer to give them guidance when students are in a trouble.</p>
<p>6. Other factors that influence your teaching of this idea</p>	<p>Time, prior knowledge of students, scientific knowledge of teachers, the nature of science knowledge of teachers, skills in teaching (skill in transferring knowledge to students, methods in teaching), class management skill</p>
<p>7. Teaching procedures (and particular reasons for using these to engage with this idea)</p>	<p>To encourage students to know about creativity by using a science history along with science contents is implicit because the things students will gain is just guideline of scientists' creative thinking. Leading students to learn more about creative idea explicitly can do by using instructional gears (activity, experiment) along with a science history. It could help them to see more concrete idea.</p> <p>Activities are might be a good option. Activities are learning way that let students investigate answer by themselves. Teachers might design another application activity to test their explicit understanding in a lesson.</p> <p>Creativity should appear along with process of investigation. Using games or cartoons could be good options for teachers using with their science classroom to encourage their students' creativity. Game could be included into science learning because it not only motivates students' interest, but also promotes students thinking.</p> <p>“Building a lighthouse” excerpted form http://www.creative-chemistry.org.uk/activities/lighthouse.htm, this activity could be a good example about how to use creativity in science classroom. Its goal is to encourage students' working in group in creating a model of light house which works in lighting and also being beautiful in design. Students in each group are assigned materials and limited time to work. The challenge of this activity is how to create the best efficient model for their group.</p> <p>Teacher might let students create their own cartoon story from a lesson they have learned. This activity can test students' understanding. Here is the link that students can use to create their own</p>

	<p>work. http://www.makebeliefscomix.com.</p> <p>Supporting students to do the concept mapping is another creative activity that works for science classroom, beneficially in reflecting students' thinking in science. Concept mapping can determine students' ideas in linking their knowledge structures, (Luli & Hellden, 2004; Vanides, Yin, Tomita, & Ruiz-Primo, 2005). It is an approach that provides students a change to demonstrate "conceptual understanding and higher-order of cognitive processes such as explaining and planning" (Vanides, Yin, Tomita, & Ruiz-Primo, 2005,p.31). That is good to know that how much students understand in a topic because if they can link the relationship among important concepts, it shows that they have a clear understanding. Teacher may recommend them to use a picture and mixingcolor to make their concept mapping easy to read and interesting to show information. <i>See an example of concept mapping at Appendices: Figure1.</i></p>
<p>8. Specific ways of ascertaining students' understanding or confusion around this idea (including likely range of responses).</p>	<p>Creativity makes a variety in science. It is very important for science students to have because it promotes them to think in solving problems by their own way that leads them to success in science. Main idea that students should realize when they want to do experiment or doing science activity is they can select to use various ways to figure out problem not just follows step-by-step from instruction books, and also they can use creativity be involved in all steps of science process.</p> <p>For integrating creativity into science learning, to evaluate students' success with this idea, teacher might set a scientific question, let students plan their own ways, and then do an experiment to test their hypotheses. Every step should be solved by themselves. Teacher could know whether they understand about NOS idea while they do an experiment. Using a rubric is a good way that teacher can do along with observing students' understanding because a rubric consists of a standard to examine if students have a performance that teacher wants they should have. http://rubistar.4teachers.org/index.php This website provides a pattern to make a rubric. Teacher might use this website to create his own rubric to use in a classroom.</p>

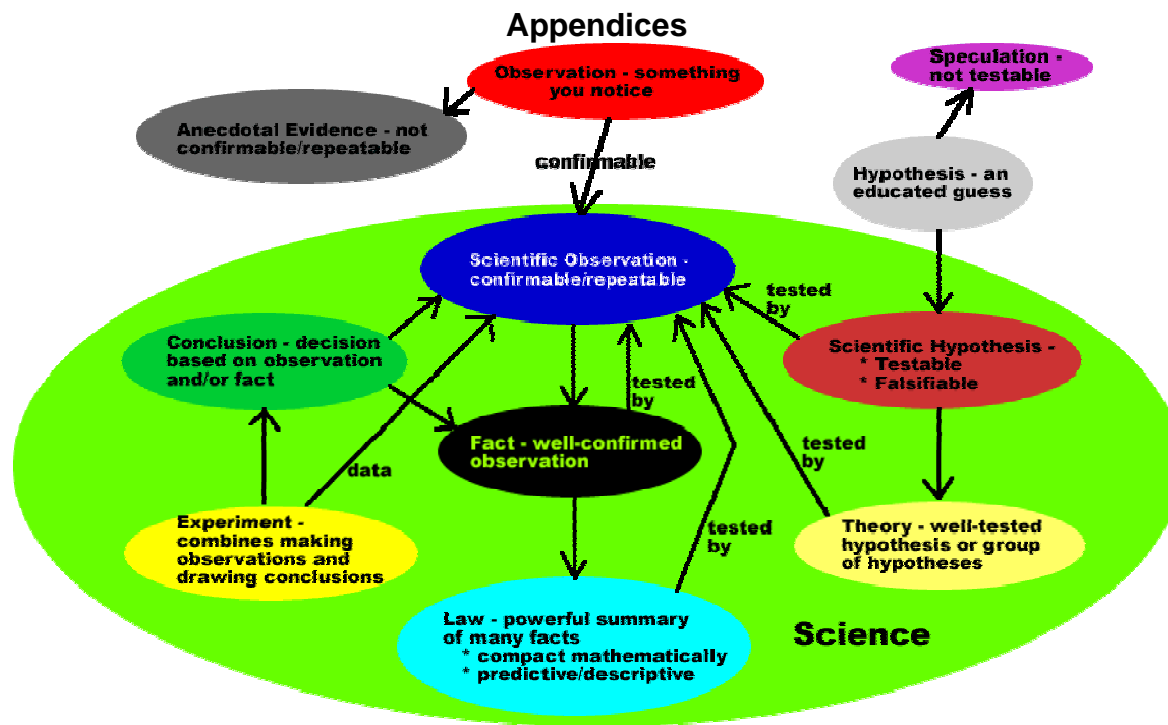


Figure 1: Science concept map.

From: http://www.batesville.k12.in.us/Physics/PhyNet/AboutScience/concept_map.htm

Reference

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