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# Encouraging Creativity in a STEM Classroom

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The Thailand Ministry of Education's "Institute for the Promotion of Teaching Science and Technology" (IPST) uses the following as its working definition of STEM:

> *"STEM education integrates science, engineering, technology and mathematics focusing on the application of knowledge to real-life problem solving and development of new products or procedures benefiting daily living and livelihood. STEM education infuses the engineering process into the existing science, mathematics and technology curricula to enable utilization of the knowledge to solve actual problems and aid future occupational undertakings."*

A key part of this statement are the words: "…*to enable utilization of the knowledge to solve actual problems and aid future occupational undertakings*."

To be able to utilize information means that the person who knows the information must be able to rearrange it in his/her mind, to see new possibilities for using the knowledge, to be able to consider alternative meanings to the knowledge then that which was initially learned in school. In other words, to utilize the knowledge the person needs to be creative.

What does it mean to be *creative*? Here are some definitions[1]:

- "Creativity is seeing what everyone else has seen, and thinking what no one else has thought." – Albert Einstein
- "Creativity is the ability to generate innovative ideas and manifest them from thought into reality. The process involves original thinking and then producing." – Wikipedia.com
- "Creativity is the ability to find new solutions to a problem or new modes of expression; thus it brings into existence something new to the individual and to the culture." – Dr. Betty Edwards

In any classroom, not just STEM ones, teachers want their students to be creative. To be able to write a poem, to analyze a reading, to draw a conclusion from experimental data, to use their knowledge and not to just regurgitate it.

So how can teachers engender creativity in their students?

This article will provide some examples of how the author has been doing so for the past 40+ years in his classes.

## Setting the stage

Students can learn to be more creative if given multiple opportunities to be creative.

- Start early in the course, by the end of the first 3 weeks is a good time to begin with creative activities,
- Ask students to do creative activities throughout the course,
- The creative activities use a variety of methods,
- The creative activities can be graded for completion or based on specific criteria.

## Examples of creative activities in practice

**Figure 1 : Element Poster** shows a student poster advertising the element that was randomly assigned to him/her. To make this a good quality poster the student must know something about the element assigned and be able to use this information in a creative way – an advertisement.


**Figure 1**

**Figure 2 : Tombstone** is a creative project where a student must create a tombstone or epitaph for a famous person.

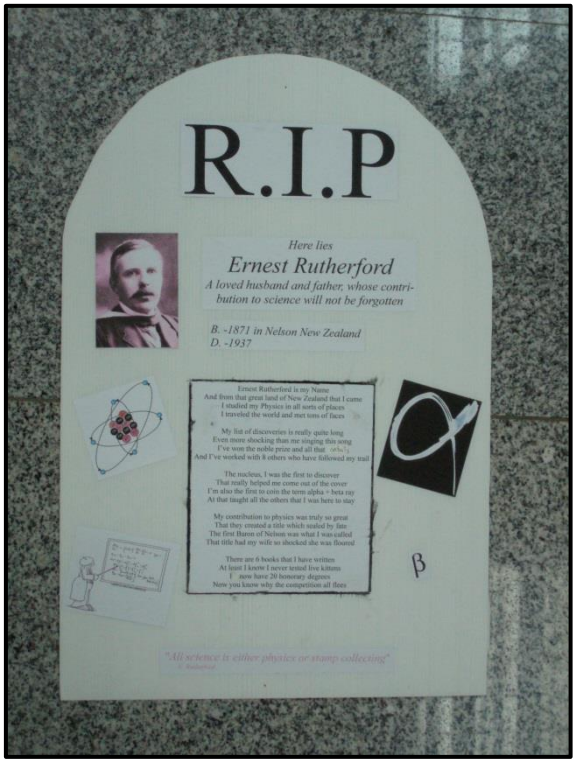



**Figure 2**

**Figure 3 : Design-a-Lab** is an assignment where students had to gather data and analyze it based on a data gathering procedure that they came up with.

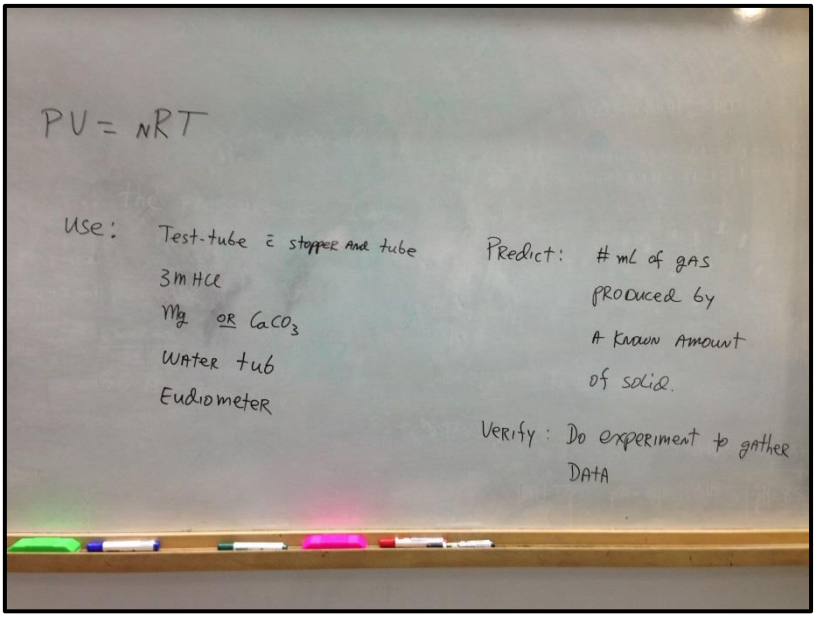



**Figure 3**

**Figure 4 : Design-a-Lab Report** show's how the students for another design-a-lab reported their findings.

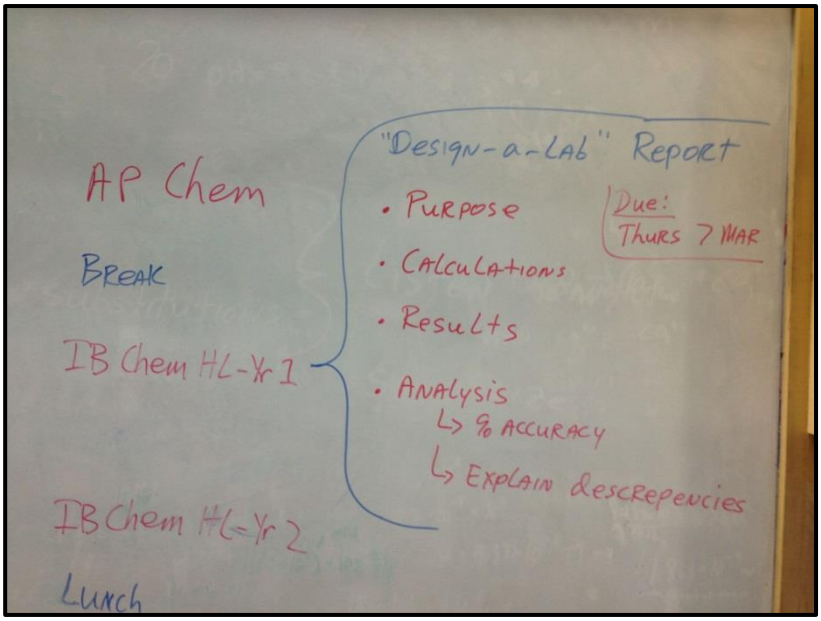
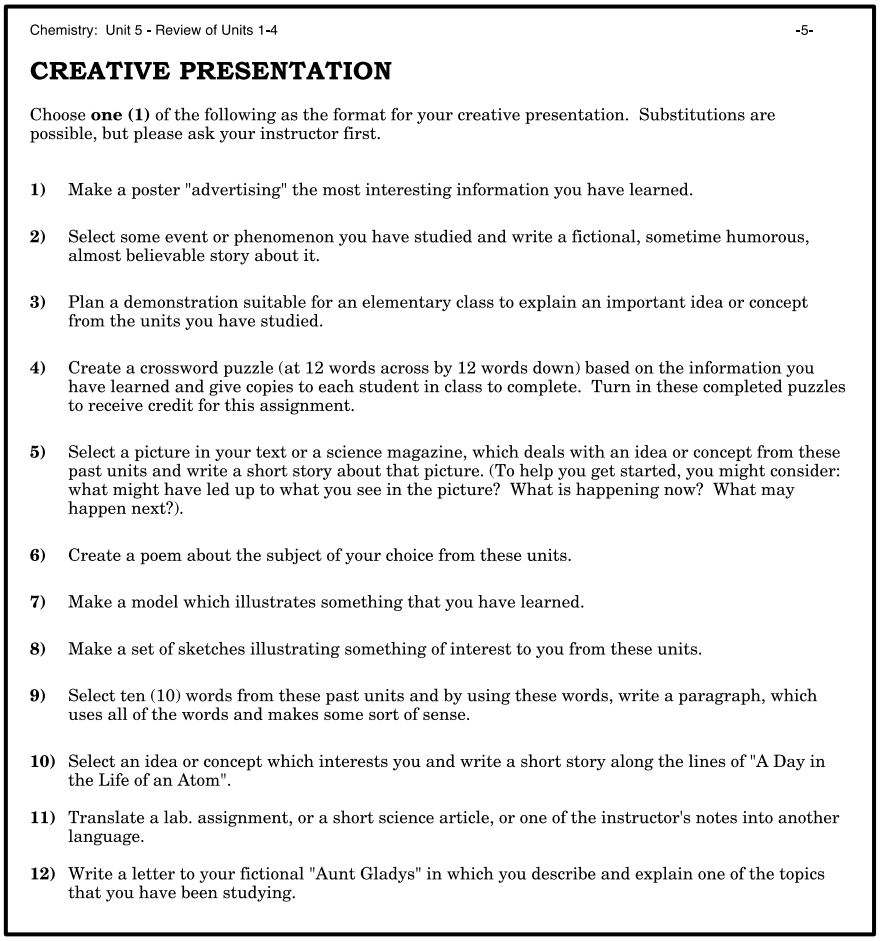



**Figure 4**

**Figure 5 : Creative Presentation List** show's the choice's that student's were given at the end of each 9 weeks for a required creative presentation.



Chemistry: Unit 5 - Review of Units 1-4 -5-

**CREATIVE PRESENTATION**

Choose **one (1)** of the following as the format for your creative presentation. Substitutions are possible, but please ask your instructor first.

**1)** Make a poster "advertising" the most interesting information you have learned.

**2)** Select some event or phenomenon you have studied and write a fictional, sometime humorous, almost believable story about it.

**3)** Plan a demonstration suitable for an elementary class to explain an important idea or concept from the units you have studied.

**4)** Create a crossword puzzle (at 12 words across by 12 words down) based on the information you have learned and give copies to each student in class to complete. Turn in these completed puzzles to receive credit for this assignment.

**5)** Select a picture in your text or a science magazine, which deals with an idea or concept from these past units and write a short story about that picture. (To help you get started, you might consider: what might have led up to what you see in the picture? What is happening now? What may happen next?).

**6)** Create a poem about the subject of your choice from these units.

**7)** Make a model which illustrates something that you have learned.

**8)** Make a set of sketches illustrating something of interest to you from these units.

**9)** Select ten (10) words from these past units and by using these words, write a paragraph, which uses all of the words and makes some sort of sense.

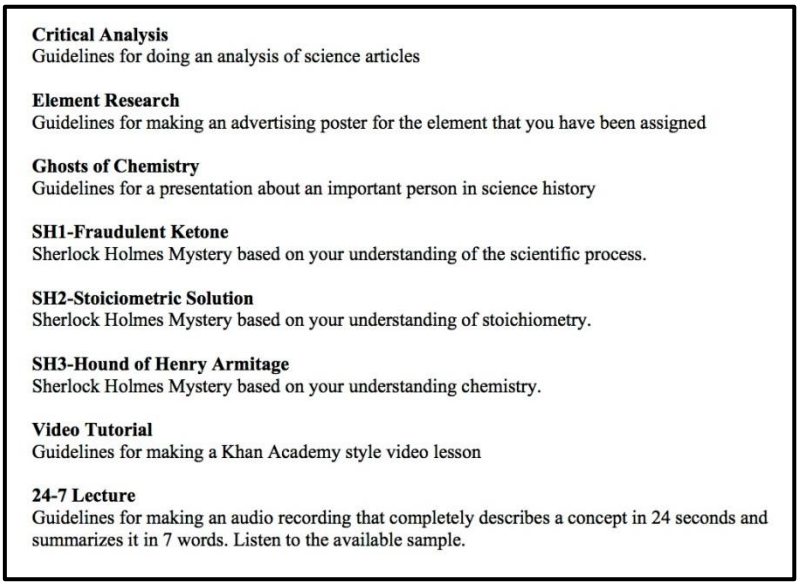
**10)** Select an idea or concept which interests you and write a short story along the lines of "A Day in the Life of an Atom".

**11)** Translate a lab. assignment, or a short science article, or one of the instructor's notes into another language.

**12)** Write a letter to your fictional "Aunt Gladys" in which you describe and explain one of the topics that you have been studying.

**Figure 5**

**Figure 6 : Project List** shows the creative projects that are assigned throughout the semester.



**Critical Analysis**
Guidelines for doing an analysis of science articles

**Element Research**
Guidelines for making an advertising poster for the element that you have been assigned

**Ghosts of Chemistry**
Guidelines for a presentation about an important person in science history

**SH1-Fraudulent Ketone**
Sherlock Holmes Mystery based on your understanding of the scientific process.

**SH2-Stoiciometric Solution**
Sherlock Holmes Mystery based on your understanding of stoichiometry.

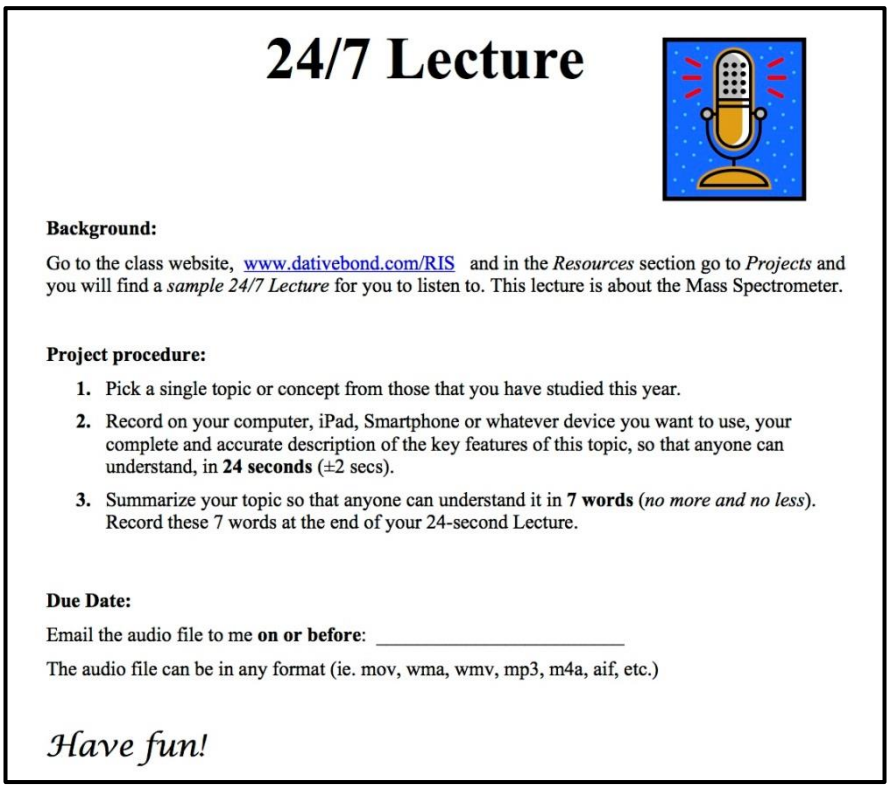
**SH3-Hound of Henry Armitage**
Sherlock Holmes Mystery based on your understanding chemistry.

**Video Tutorial**
Guidelines for making a Khan Academy style video lesson

**24-7 Lecture**
Guidelines for making an audio recording that completely describes a concept in 24 seconds and summarizes it in 7 words. Listen to the available sample.

**Figure 6**

**Figure 7 : 24-7** shows the directions for making the 24-7 audio presentation.



# 24/7 Lecture

**Background:**

Go to the class website, www.dativebond.com/RIS and in the *Resources* section go to *Projects* and you will find a *sample 24/7 Lecture* for you to listen to. This lecture is about the Mass Spectrometer.

**Project procedure:**

1. Pick a single topic or concept from those that you have studied this year.
2. Record on your computer, iPad, Smartphone or whatever device you want to use, your complete and accurate description of the key features of this topic, so that anyone can understand, in **24 seconds** (±2 secs).
3. Summarize your topic so that anyone can understand it in **7 words** (*no more and no less*). Record these 7 words at the end of your 24-second Lecture.

**Due Date:**

Email the audio file to me **on or before**: _____

The audio file can be in any format (ie. mov, wma, wmv, mp3, m4a, aif, etc.)

*Have fun!*

**Figure 7**

The 24/7 activity is particularly fun experience when the students turn them in. In order to summarize a concept in 24 secs. the student must have a clear idea of what the concept is about and be able to use their knowledge of science and language to summarize the concept in 7 words. Very challenging and yet fun to do!

**Putting creativity into action**

In the many schools around the world students are assigned a major project to do, for example schools that use the International Baccalaureate (IB) program. In the IB program each year students are randomly assigned into groups of Biology, Chemistry and Physics students and given a common theme to investigate, such as:

- "Things Thai", i.e. Thai rice, Thai silk, Thai coconut.
- "Design the habitat for a human settlement on Mars."
- "Transportation at school".

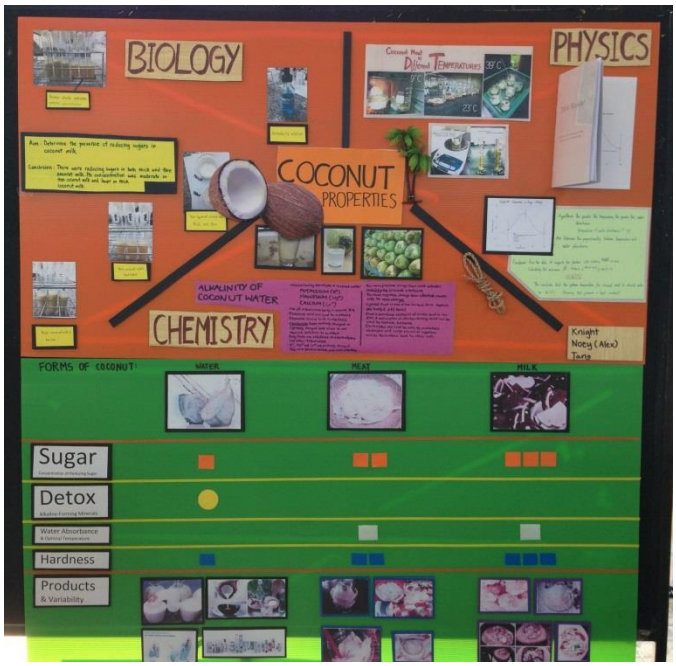
The purpose of this assignment is to:

- Emphasize the interdisciplinary cooperation and the processes involved in scientific investigation and that relate to STEM.
- Have students analyze a topic or problem that is offered by the school.
- Incorporate Biological, Chemical and Physics concepts and data.
- Allow appreciation of the environmental, social, and ethical implications of science.
- Help students to understand the limitations of scientific study.

- Provide a means by which students can utilize the creative problem-solving skills that they have developed in their classes to be able to solve a real life problem like those listed above and shown in the Figures 8 – 10 that follow.

Doing these projects without some experience in being creative would be very difficult, if not impossible for most students. Solving real-live problems requires more than using memorized formulas and ideas, it requires the ability to take disparate ideas, concepts and knowledge and put them together as something new. In other words being creative! (See the three definitions at the beginning of this article).

The following figures are examples of some real-life problems solving investigations made by students:




The topic given as to investigate "Things Thai". These students asked themselves:

**1)** Are reducing sugars present and does the amount depend on the viscosity of the milk? (Biology)
**2)** Determine the proportionality between temperature and water absorbance (Physics)
**3)** What properties of coconuts can be compared/ (Chemistry)

**Figure 8 – Investigating the Biology, Chemistry & Physics of Coconuts**

In this investigation students asked themselves what happens to a person's blood pressure if:

**1)** the kind of music being listened to changes
**2)** what the person is drinking changes.

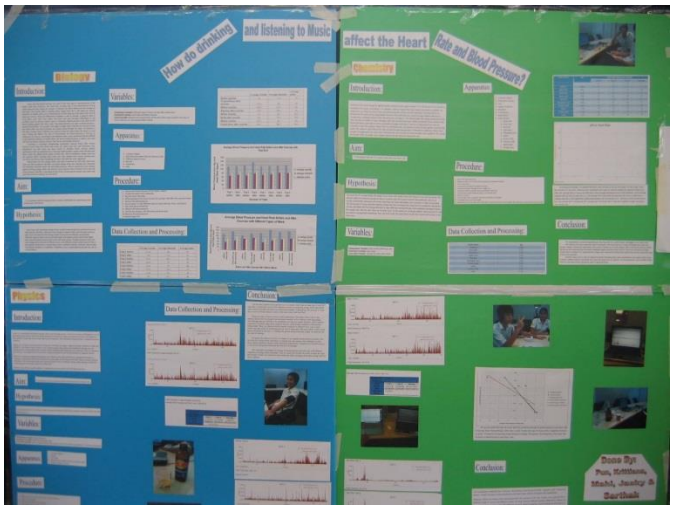
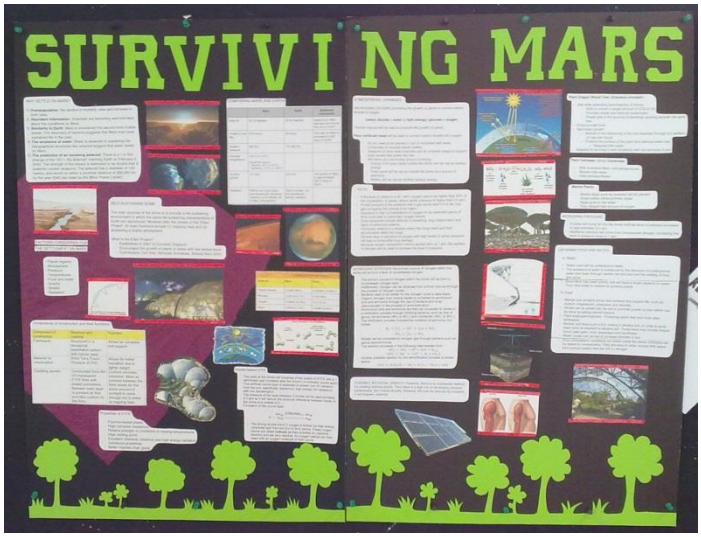



**Figure 9 – Investigating the Effects on Blood Pressure**




Students were challenged to design a human habitat on Mars. To do this they needed to know what are the minimum necessities for humans to survive and then to figure out how to arrange for them on Mars.

**Figure 10 – Designing a Human Habitat on Mars**

## Why is teaching students to be creative important?

Searching Google with the query "teaching creativity" results in "about 98,900,000 results (0.45 seconds)" so this is not a topic of minimal interest!

In an Educational Leadership article Sir Ken Robinson[6] states:

*"What's the biggest misconception people have about creativity?*

> *One is that it's about special people—that only a few people are really creative. Everybody has tremendous creative capacities. A policy for creativity in education needs to be about everybody, not just a few.*

*The second misconception is that creativity is about special activities. People associate creativity with the arts only. I'm a great advocate of the arts, but creativity is really a function of everything we do. So education for creativity is about the whole curriculum, not just part of it.*

*The third misconception is that creativity is just about letting yourself go, kind of running around the room and going a bit crazy. Really, creativity is a disciplined process that requires skill, knowledge, and control. Obviously, it also requires imagination and inspiration. But it's not simply a question of venting: It's a disciplined path of daily education. If you look at some of the people we most respect for their creative achievements, it's because of the extraordinary insights, breakthroughs, and discipline they have brought to their work."*

In a similar vein, another author says[7]:

*So what's a society to do? Especially one committed to constant innovation? Foster imaginative thinking? Check. Nurture can-do attitude and audacity of vision? Check. But most important of all, we can immerse our students in recreating creative process. … The more paths to creativity that students explore vicariously and recreates mentally, the better prepared they will be to recognize opportunities for creative achievement in their own lives."*

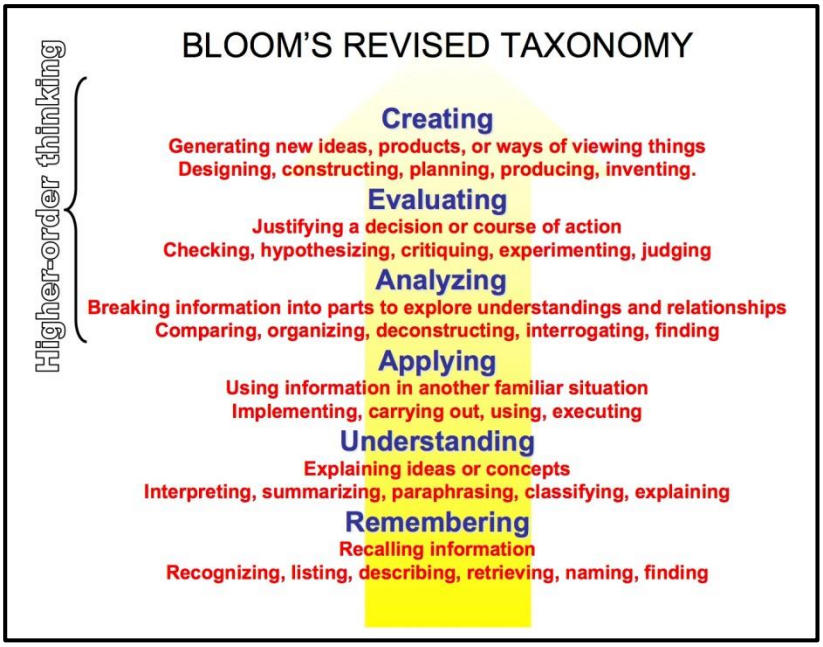



**Figure 1**

Both of these writers are arguing for the same thing, provide ample opportunities for students to be creative.

A guide for developing curriculum for the past 30+ years has been Bloom's Taxonomy. The modern version of this taxonomy shows the importance of creativity.

## Conclusion

Encouraging creativity is a process, not a prescription. Student creativity happens when students feel comfortable with their teacher, when their efforts are accepted for what it is and when the opportunities to be creative happen over and over again.

Hopefully this article has given you some new tools to use in your classroom to encourage your students to be creative! Have fun!

David finished his 41st year of teaching in June of which 32 years were in Arizona and the last 9 years in Bangkok, Thailand. He mainly taught high school chemistry and physics. He also taught community college chemistry, university courses for future teachers and for current teaching assistants, and an NSF sponsored 4-year summer program that introduced teachers to technology. He was also the PhysTEC Physics Teacher in Residence in The University of Arizona's Dept. of Physics for three years. He especially enjoyed the students and colleagues that he met and worked with in each of these experiences.

**Acknowledgements**

1. http://celestra.ca/top-10-creativity-definitions/
2. **Figures 1 & 2** are work from students in the author's past classes.
3. **Figures 3 & 4** are assignments written on the class white board by the author.
4. **Figure 5** is an assignment given to students each quarter as part of the quarter review by the author.
5. **Figures 6 & 7** are assignments by the author and can be found on his class website at http://www.dativebond.com/Ris/Resources/downloads/index.html
6. *Teaching for the 21st Century*, Educational Leadership, Sept 2009, Vol 67 #1, Pages 22-26
7. *Teaching the Creative Process*, Psychology Today, May 21, 2011 by Michele and Robert Root-Bernstein
8. **Figures 8 – 10** are from pictures taken by the author of student work at Ruamrudee International School
9. **Figure 11** is from http://saraeffron.wordpress.com/tag/blooms-revised-taxonomy/