Physics : Part 1: Video 2 : Questions' Role in Critical Thinking

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About Critical Thinking

- Sometimes, scientists and engineers often mistakenly believe that they are well trained in critical thinking because their education and usual career path involve substantial exercises in the problem solving.

- But the analytical type of problem-solving learned by scientists and engineers is not the same as critical thinking.

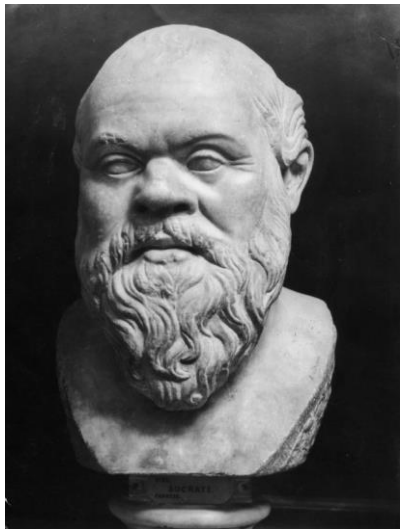
J. Carr, *The Art of Science*, 1992, HighText Pub..

A Rare Thing

Critical thinking is of great importance to all educated people, yet it is a rare and precious thing.

The unexamined life is not worth living.

Socrates



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Habits of Critical Thinking

- Brilliant students and innovators create their own victories by practicing habits of critical thinking inevitably carry them step-by-step to works of greatness.

- These habits will automatically cause you to regularly produce new knowledge and insight.

- More importantly, you yourself can master and apply these strategies.

E.B. Burger and M. Starbird, *The Five Elements of Effective Thinking*, 2012, Princeton U. Press.

Strategies of Critical Thinking

1. Understand Deeply
2. Failure to success
3. Creating Questions : Be your own Socrates
4. Seeing the Flow of Ideas
5. Engaging Change

These are the 5 habits of a critical mind.

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Habits of a Critical Mind 1

- Understand Deeply : Grounding your thinking

- It is not memorizing facts.
- Understanding the meaning and connections of ideas.
- Develop your own reasoned opinions.
- Revisit fundamentals.
- True experts continually deepen the mastery of the basics.
  Successful people regularly focus on the core purpose of their profession or life.

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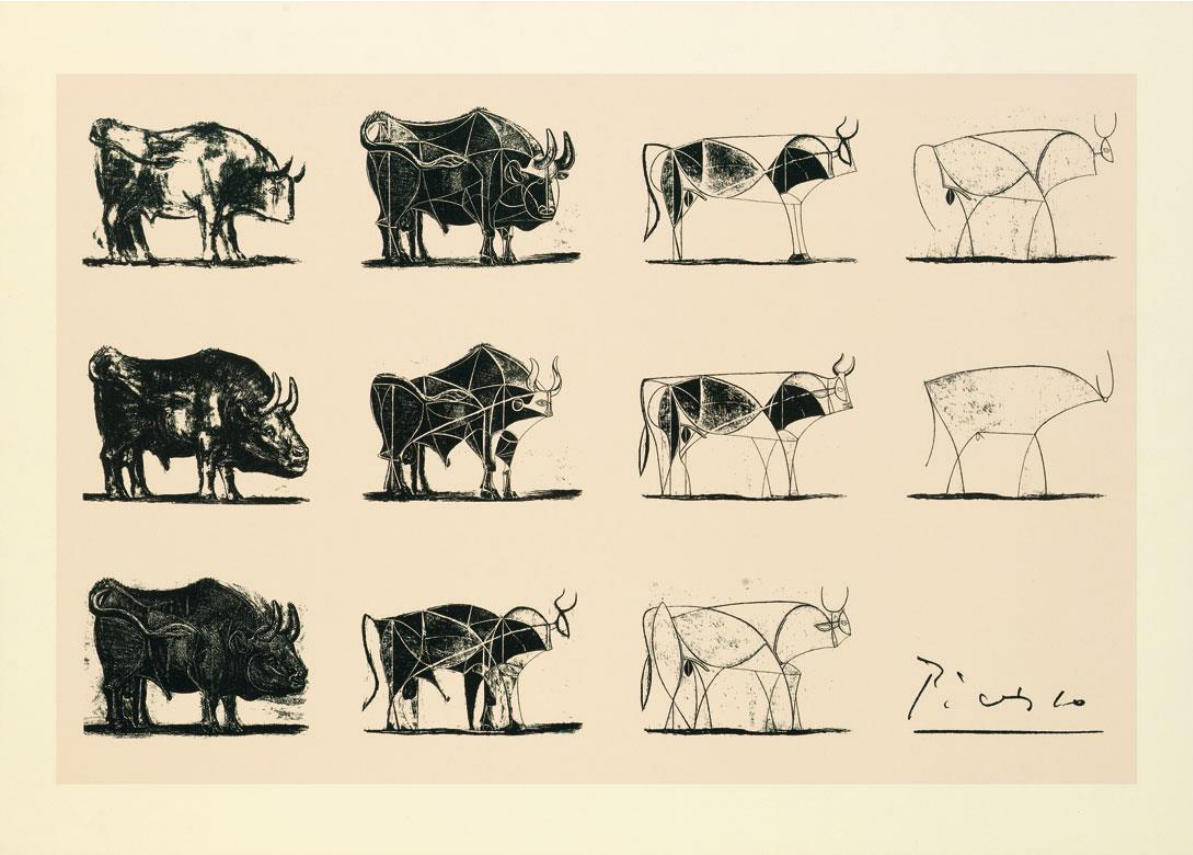
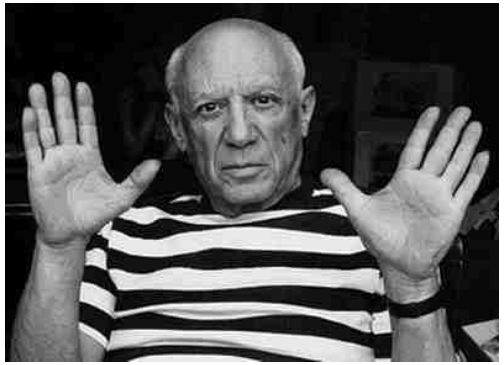
An Example : Seek Essentials



There is no abstract art. You must always start with something. Afterward you can remove all traces of reality. P. Picasso



http://behindthecreativity.tumblr.com/post/13577860911/pablo-picasso-bull-plates-i-xi-1945-46-a

An Example : Understand Deeply

- Understand Deeply : Grounding your thinking
- Two Violinists : : A Novice vs an Expert

  Scales
  Intonation

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Habits of a Critical Mind 2

- Failure to success : Igniting insights through mistakes

- Welcome accidental mis-steps; (with a sense of humour)
- Let your errors be your guide.
- Failure is also a sign of a creative mind, of original thought and strength.
- Being willing to fail is a liberating attribute of transformative thinking.

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Examples from History : Failure to Success

- A man's errors are his portals of discovery. James Joyce

- A ship in port is safe but that's not what ships are built for.
  Admiral Grace M. Hopper

- The way to get good ideas is to get lots of ideas and throw the bad ones away. Linus Pauling

- Success is the ability to go from one failure to another with no loss of enthusiasm. Winston Churchill

- Strive not to be a success, but rather to be of value. A. Einstein

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Habits of a Critical Mind 3

- Creating Questions : Be your own Socrates

- Constantly thinking of questions is a mind set with tremendous impact.
- Asking Meta-questions or Auxiliary-questions
- This habit will transform one into an active listener.

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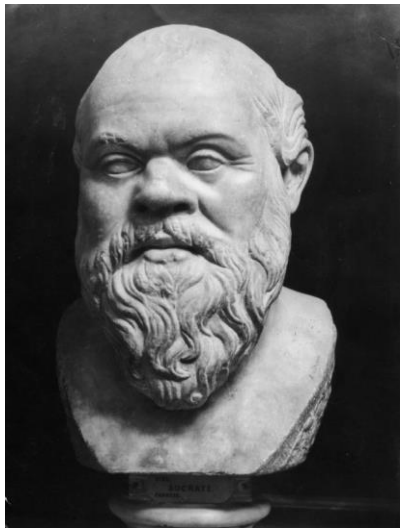
Examples from History : Creating Questions

Confident leaders in every profession are not afraid to ask the stupid questions … Paradoxically, when you ask basic questions, you will more likely be perceived by others to be smarter.

Socrates is perhaps the most famous philosopher in human history because of his method of generating ideas. He challenges his students, friends and even enemies to make new discoveries by asking them uncomfortable, core questions.



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Examples : A Questionable habit

Listening is not enough !

If you are constantly engaged in asking yourself questions about what you are hearing, you will find that even boring lectures become a bit more interesting, because much of the interest will be coming from what you are generating rather than what the lecturer is offering

When someone else speaks, you need to be though provoking.

So creating questions is as important as answering them, if not more so, because framing good questions focus your attention on the right issues.

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Habits of a Critical Mind 3

- Creating Questions : Be your own Socrates

- Teachers often misunderstand their roles in enabling their students to learn. It is tempting to view the good teacher's job as chewing up the knowledge into morsels small enough for the students to swallow. But the real goal is for students to develop skills and attitudes that will allow them to independently think through the complications of life and find ways to learn for themselves.

- Sometimes we teachers may be asking the wrong question, when we ask, "How can I make this difficult material easier for my students?"

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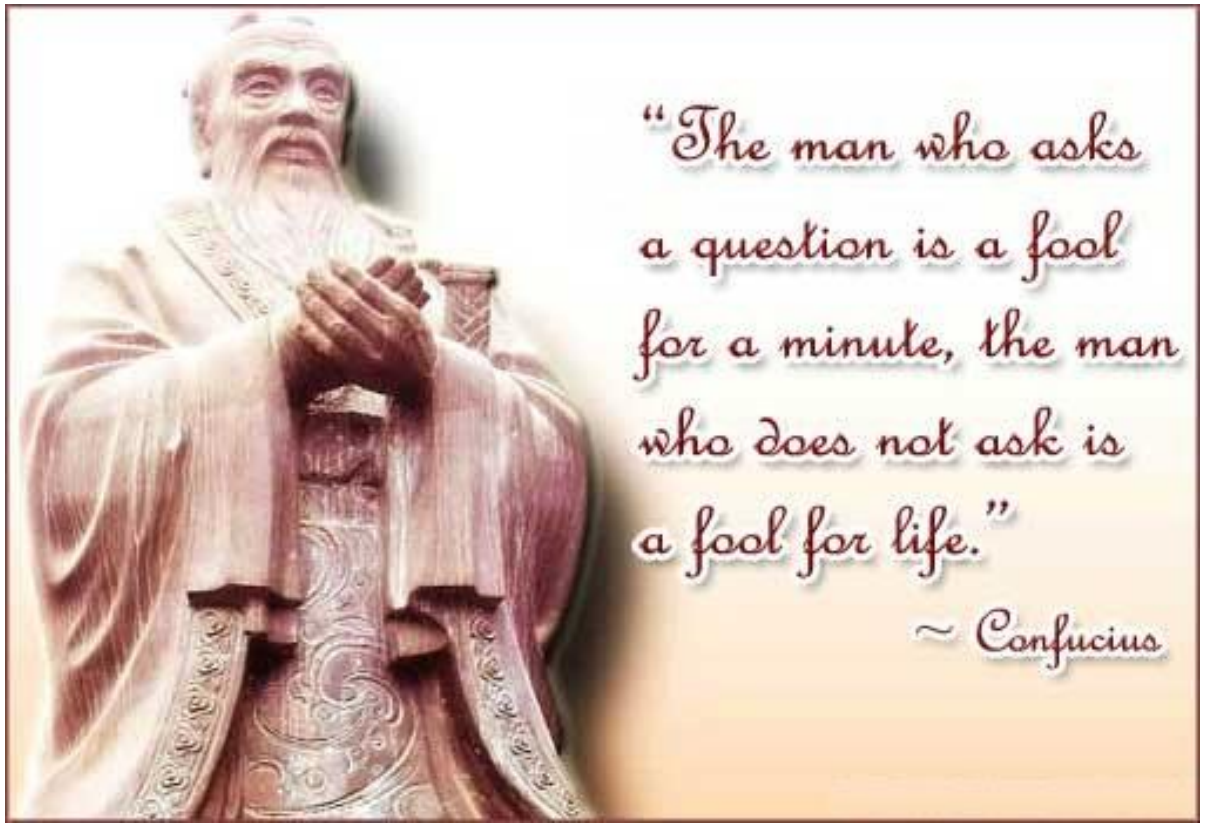
It is hard to know what you do not know

Honest Scholarship

To hold that you know a thing when you know it and to hold that you do not know when you really do not know. … that is knowledge.

Confucius, Analects



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Habits of a Critical Mind 4

- Seeing the Flow of Ideas : Look back and look forward

- Iterate ideas
- Understanding current ideas through the flow of ideas
- Think back.
- Guessing what's next anchors what's there.
- Under construction is the norm … life long journey.

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Examples from History : Flow of Ideas

As you are learning a topic, ask yourself what previous knowledge and what strategy of extending previous ideas making the new idea clear, intuitive, and a natural extension.

When we see and understand, these new ideas are connected, they become more interesting, more memorable and more meaningful.

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Examples from History : Flow of Ideas

To truly understand a concept, discover how it naturally evolves from a simpler thoughts … All creative people, even ones who are considered geniuses, start as non-geniues and take baby steps from there.

In the *Art of Fiction,* Hemingway revealed that practiced the technique of incremental progress. In fact he rewrote the ending of *A Farewell to Arms*, 39 times before he was satisfied.

To improve the golden moments of opportunity, and catch the good that is within our reach, is the great art of life. Samuel Johnson

Ernest Hemingway, *The Art of Fiction*, 1956 Paris Review.
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Habits of a Critical Mind 5

- Engaging Change : Transform your thinking

- Just do it.
- Like the way to happiness, the path to change is not through greater will power and harder work, but rather through thinking differently.
- But often the real problem is following the instructions.

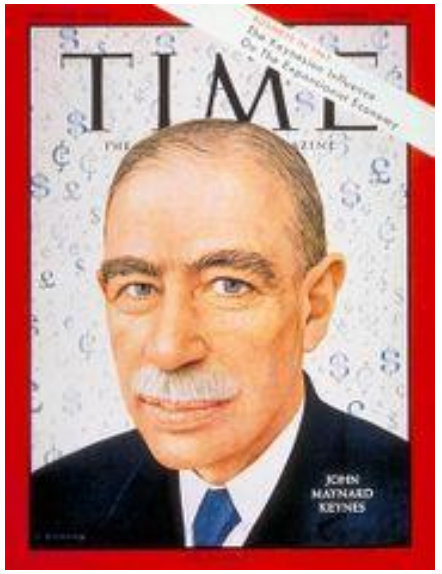
E.B. Burger and M. Starbird, *The Five Elements of Effective Thinking*, 2012, Princeton U. Press.

Examples from History : Engaging Change

What is the real difficulty ?

The difficulty lies, not in the new ideas, but in escaping from the old ones, which ramify, for those brought up as most of us have been, into every corner of our minds.

J.M. Keynes
(1883-1946)



Summary

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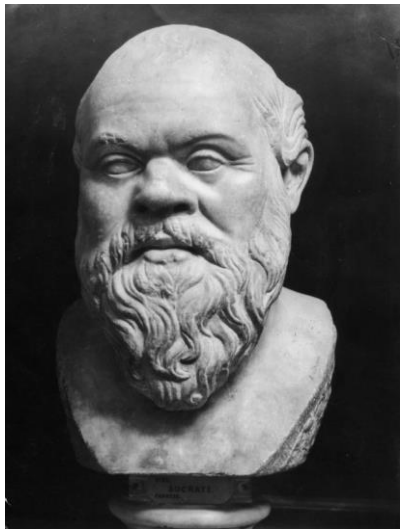

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Appendix : A Caveat, Critical Thinking

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Comments : Critical Thinking

- Although most college degree programs once included courses designed to teach thinking, and many other courses conscientiously incorporated critical thinking skills and practices, more and more colleges are herding their students towards knowledge-based courses that lead to jobs in the near term.
- In the dynamic culture where technical and scientific knowledge is raised up and overthrown a dozen times in the course of a scientist's career, the ability to regurgitate facts and formulas that are of value today… but obsolete tomorrow.

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Comments : Critical Thinking

- Most of the problems faced by such students are strictly monological. Such problems are inherently easier to solve than mult-ilogical original research problems. Furthermore, once you get away from the type of problems that succumb to a differential equation, a bit of algebra, or a numerical analysis, our methods fall down, and may actually burden us.
- Abstract thought, and solving problems for which there is neither a correct answer or even a good answer is considerably more difficult.

J. Carr, *The Art of Science*, 1992, HighText Pub..