

Research Methodology in CSE, MTech-I (1st semester)

Chapter 1: Introduction & Overview

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Chapter 1: Topics of Study

- **Introduction:** What Is Research? Definition, Characteristics, Motivation and Objectives, Research Methods vs Methodology. Research as an integral part of professional practice. A way to gather evidence for practice. Evidence-based practice. Applications of research in practice. Development and policy formulation.

Overview of the research process: its characteristics and requirements Types of research: Descriptive vs Analytical, Applied vs Fundamental.

Overview of Research Designs: Quantitative vs Qualitative vs Mixed Methods Designs. Conceptual vs Empirical.

Research Process & Methodology: The research process as an eight step model. Deciding what to research. Planning how to conduct the study. Conducting the research study.

[DCJ: 4 hours]

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 - for which **the question may not be known or articulated before the research/answer**
- In the process, this exercise creates **new knowledge** which is interesting/useful

What is research?...

- Research is defined as the **creation of new knowledge** and/or
- the use of existing knowledge in **a new and creative way** so as to generate new concepts, methodologies and understandings.
- This could include **(re)-synthesis and analysis of previous research** to the extent that it leads to new and creative outcomes.



Figure: Research Process

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 - Acceptance plan - validation by the customer

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- the **new** approach must **create** a useful artifact or **improve an existing** artifact

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- will discuss it further but simplest answer is **read, read, read,..... the state-of-the-art papers.**

Revisited: How vital is the newness-usefulness?

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What is research? Other perspectives...

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 - to **InRedinvestigate** the possibilities and ways for **InRedfurther** improvements and refinements.

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 - that helps one **to understand and formulate guiding principles** that govern a particular procedure in practice,
 - that **develop and test new ways** that contribute to the advancement of practice and profession.

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Research Methodology

the knowledge of research methodology provides one with the techniques to find answers to research questions.

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 - So, though such problems may be difficult, they are not research problems.



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*The conclusion at the end has to be new for research
Now when one starts, the conclusion obviously is not
known.... So, How does one even start?*

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- A strong guess can turn into a belief.

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 - the known techniques are not appropriate for the work.
- Negative results
 - the initial target and similar other targets are not realisable.

The Value of Failure in Science

The screenshot shows a web browser displaying an article from the journal *Frontiers in Neuroscience*. The article is a 'CONCEPTUAL ANALYSIS' type, published in the journal *Front. Neurosci.* on 24 October 2019, under the section 'Sec. Perception Science'. The DOI is <https://doi.org/10.3389/fnins.2019.01121>. The title of the article is 'The Value of Failure in Science: The Story of Grandmother Cells in Neuroscience'. The author is Ann-Sophie Barwich, whose profile picture is shown next to her name. Below the author's name is the affiliation: Department of History and Philosophy of Science and Medicine, Cognitive Science Program, Indiana University Bloomington, Bloomington, IN, United States. To the right of the article title, there is a teal button labeled 'Download Article' and a circular icon showing '28,307' total views with a '70' indicating recent activity. Below the views counter is a button labeled 'View Article Impact'. At the bottom of the page, there are social sharing links for Twitter, LinkedIn, and Facebook. The browser's address bar shows the URL <https://www.frontiersin.org/articles/10.3389/fnins.2019.01121/full>.

Figure: <https://www.frontiersin.org/articles/10.3389/fnins.2019.01121/full>

The Value of Failure in Science ...

<https://www.jstor.org/stable/24119072>

jstor.org/stable/24119072

Preview

IRI ACHIEVEMENT AWARD ADDRESS

IN RESEARCH, FAILURE IS THE PARTNER OF SUCCESS

John Backus

Failure is one of the most common difficulties that researchers face—and the one least talked about.

The movies have always portrayed research as a glamorous and thrilling enterprise, one in which inspiration and happy persistence have wonderful results, results that bring the researcher fame and glory, all within an hour or two.

But you don't hear very much about the real human difficulties and discouragement that are such an inevitable part of research. And the result of this glamorization is that many gifted young people, who might have made valuable contributions, fail to do so.

You may say that portraying research as only exciting should attract more people to it, and of course you're right. And on a small, momentous historical note, I

disparity between their inflated image of what research should be like and the often harsh reality of actually doing research.

I believe that this tendency to quit research, which I see so much of, is a problem that managers should be more concerned about, because it results in the loss of much talent.

In Search of Excellence repeatedly observes that encouraging people to be innovative often has really astounding results, that many people you might not expect to be creative turn out to make really valuable contributions.

JOURNAL ARTICLE
IN RESEARCH,
FAILURE IS THE
PARTNER OF SUCCESS

John Backus

Research Management
Vol. 27, No. 4 (July-August 1984), pp. 26-29 (4 pages)
Published By: Taylor & Francis, Ltd.

RESEARCH MANAGEMENT

<https://www.jstor.org/stable/24119072>

Figure: <https://www.jstor.org/stable/241190721>

Journey: Top to Bottom

Subject → Area → Topic → Problem

- Usual journey is from top-to-bottom.

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 - The first two stages are usually evident.

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 - Getting a good problem is more than half the work.
 - Sometimes the journey can be bottom-up.
 - This can happen : when you are led to a problem through a connection to another problem whose top-structure is different.

- Reading and learning.

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- Others: installing computers and software, emails, administration (filling-up forms), ...

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You and your research

- Read the paper **You and your research** by **Richard W Hamming**, Bell Communications Research Colloquium Seminar, 7th March 1986

What Thinking Skills are required in research ?

- Creativity

- Creativity
- Problem solving

- Creativity
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Reproductive and Productive thinking

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Reproductive and Productive thinking

- Our thinking is generally reproductive i.e. based on the similar problems encountered in the past or the problems one is taught to solve.
- However, we must learn to do productive thinking i.e. generate as many alternate approaches as possible

Levels of thinking - ordered low to high

- ① Knowing

What is creativity

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- An example to illustrate what is critical thinking or creativity?

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What is creativity

- An example to illustrate what is critical thinking or creativity?
- Ability to apply knowledge equips one with creative thinking. What is the latent inference of this statement?

- The question asked as an example was **How to cut a square piece of paper into five equal squares?**

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- Two strikingly different ways of framing this question?
- This proves clear distinction between the Creative Thinking **required in research** and mere applying knowledge to solve a problem.

Is creative thinking a gift or a skill ?

Peter Medawar's observations

- *That creativity is beyond analysis is a romantic illusion we must now outgrow*

The screenshot shows a list of five quotes from Peter Medawar, each with a small profile picture, the quote text, the author's name, the number of likes, and the tags used.

- Showing 1-30 of 63**
“The alternative to thinking in evolutionary terms is not to think at all.”
— P.B. Medawar
tags: evolution, science, thinking 25 likes
- “The human mind treats a new idea the same way the body treats a strange protein; it rejects it.”
— P.B. Medawar
tags: evolution, science, thinking 19 likes
- “The spread of secondary and latterly of tertiary education has created a large population of people, often with well-developed literary and scholarly tastes, who have been educated far beyond their capacity to undertake analytical thought.”
— Peter Medawar
tags: critical-thinking, education 16 likes
- “I cannot give any scientist of any age better advice than this: the intensity of the conviction that a hypothesis is true has no bearing on whether it is true or not.”
— Peter B. Medawar, Advice To A Young Scientist
tags: advice, conviction, hypothesis, science, scientist, wishful-thinking 14 likes
- “There is no such thing as a Scientific Mind. Scientists are people of very dissimilar temperaments doing different things in very different ways.”

Figure: Medawar's Quotes about Creativity

What is the difference between the intelligence and the creativity?

What is the difference between the intelligence and the creativity?

The screenshot shows the Wikipedia article for Marilyn vos Savant. At the top, there are tabs for 'Article' (which is selected) and 'Talk'. Below the tabs are buttons for 'Read', 'Edit', 'View history', and a search bar with the placeholder 'Search Wikipedia' and a magnifying glass icon. The main title 'Marilyn vos Savant' is bolded. Below the title, it says 'From Wikipedia, the free encyclopedia'. The article text describes her as an American magazine columnist who has the highest recorded intelligence quotient (IQ) in the *Guinness Book of Records*. It mentions her column 'Ask Marilyn' in *Parade* magazine and her work on the Monty Hall problem. To the right of the main text is a sidebar with a summary box for 'Marilyn vos Savant'. The summary box contains the following information:

Marilyn vos Savant	
Born	Marilyn Mach August 11, 1946 (age 75) ^[1] St. Louis, Missouri, U.S.
Occupation	Author · columnist
Spouse	Robert Jarvik (m , 1987)

Figure: Highest IQ:But mere columnist

What is the difference between the intelligence and the creativity?

Article [Talk](#) Read Edit View history Search Wikipedia

Marilyn vos Savant

From Wikipedia, the free encyclopedia

Marilyn vos Savant ([/vəs sə vənt/](#); born **Marilyn Mach**; August 11, 1946) is an American magazine columnist^[2] who has the highest recorded intelligence quotient (IQ) in the *Guinness Book of Records*, a competitive category the publication has since retired. Since 1986, she has written "Ask Marilyn", a *Parade* magazine Sunday column wherein she solves puzzles and answers questions on various subjects, and which popularised the *Monty Hall problem* in 1990.

[Contents](#) [hide]

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Article [Talk](#) Read Edit View history Search Wikipedia

Richard Feynman

From Wikipedia, the free encyclopedia

"Feynman" redirects here. For other uses, see [Feynman \(disambiguation\)](#).

Richard Phillips Feynman ([/fɛɪnmən/](#); May 11, 1918 – February 15, 1988) was an American theoretical physicist, known for his work in the path integral formulation of quantum mechanics, the theory of quantum electrodynamics, the physics of the superfluidity of supercooled liquid helium, as well as his work in particle physics for which he proposed the parton model. For contributions to the development of quantum electrodynamics, Feynman received the [Nobel Prize in Physics](#) in 1965 jointly with [Julian Schwinger](#) and [Shin'ichirō Tomonaga](#).

Feynman developed a widely used pictorial representation scheme for the mathematical expressions describing the behavior of subatomic particles, which later became known as [Feynman diagrams](#). During his lifetime, Feynman became one of the best-known scientists in the world. In a 1998 poll of 130 leading physicists worldwide by the British journal *Physics World*, he was ranked the seventh-greatest physicist of all time.^[3]

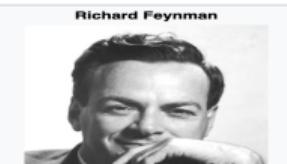


Figure: IQ 122:But Nobel prize and known as the last American genius

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Intelligent but passive

Thus one can be intelligent but **be rigid, non-creative** or lacking in the kind of **single-minded passion** that drives the **creators**

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Optimistic	Roses
Pessimistic	Thorns
Realistic	Roses and thorns
Stoic	Roses and thorns
Humane	Roses for you and roses for me
Selfish	Roses for me and thorns for you
Sadistic	Thorns for you and your blood for me
Divine	Roses for you and your thorns for me

Developing Creativity

Creativity can be developed by

- looking at the world in terms of **analogies**. What is an analogy ?

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The screenshot shows a dictionary entry for the word "analogy".
- **Definition:** analogy /ə'nalədʒi/ (noun)
- **See definitions in:** All, Philosophy, Logic, Linguistics, Biology
- **Description:** noun: **analogy**; plural noun: **analogies**
- **Meaning:** a comparison between one thing and another, typically for the purpose of explanation or clarification.
- **List of examples:**

- a correspondence or partial similarity.
"the syndrome is called deep dysgraphia because of its **analogy to** deep dyslexia"
- a thing which is comparable to something else in significant respects.
"works of art were seen as an analogy for works of nature"
- LOGIC
a process of arguing from similarity in known respects to similarity in other respects.
"argument from analogy"

- **Related terms:** Similar: similarity, parallel, parallelism, correspondence, likeness
- **List of categories:**

- LINGUISTICS
a process by which new words and inflections are created on the basis of regularities in the form of existing ones.
- BIOLOGY
the resemblance of function between organs that have a different evolutionary origin.

Figure: Analogy definitions

Creativity can be developed by

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Analogy

From Wikipedia, the free encyclopedia

For other uses, see [Analogy \(disambiguation\)](#).

Analogy (from Greek *analogia*, "proportion", from *ana-* "upon, according to" [also "against", "anew"] + *logos* "ratio" [also "word, speech, reckoning"]^{[1][2]}) is a cognitive process of transferring information or meaning from a particular subject (the analog, or source) to another (the target), or a linguistic expression corresponding to such a process. In a narrower sense, analogy is an inference or an argument from one particular to another particular, as opposed to deduction, induction, and abduction, in which at least one of the premises, or the conclusion, is general rather than particular in nature. The term analogy can also refer to the relation between the source and the target themselves, which is often (though not always) a similarity, as in the biological notion of analogy.

Analogy plays a significant role in problem solving, as well as decision making, argumentation, perception, generalization, memory, creativity, invention, prediction, emotion, explanation, conceptualization and communication. It lies behind basic tasks such as the identification of places, objects and people, for example, in face perception and facial recognition systems. It has been argued that analogy is "the core of cognition".^[3] Specific analogical language comprises exemplification, comparisons, metaphors, similes, allegories, and parables, but not metonymy. Phrases like *and so on, and the like, as if*, and the very word *like* also rely on an analogical understanding by the receiver of a message including them. Analogy is important not only in ordinary language and common sense (where proverbs and idioms give many examples of its application) but also in science, philosophy, law and the humanities. The concepts of association, comparison, correspondence, mathematical and morphological homology, homomorphism, iconicity, isomorphism, metaphor, resemblance, and similarity are closely related to analogy. In cognitive linguistics, the notion of conceptual metaphor may be equivalent to that of analogy. Analogy is also a basis for any comparative arguments as well as experiments whose results are transmitted to objects that have been not under examination (e.g., experiments on rats when results are applied to humans).

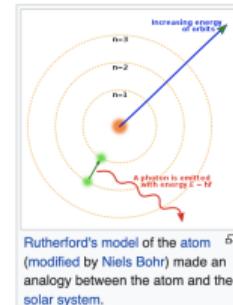


Figure: Analogy explanation on Wiki

If you have 10 hours for chopping a tree, spend at least 5 hours sharpening the axe

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Critical Thinking, again

Do we now understand on what the foundations of research rest ? Are we really prepared to undertake research ?

Back to analogies: Tutorial #1

Read the blog at <https://www.teachthought.com/critical-thinking/examples-of-analogies/>

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- Different ways of calculating π

How to initiate research ?

Building the background

Palash Sarkar@ISI, Kolkata

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Thus, One must be aware about the following

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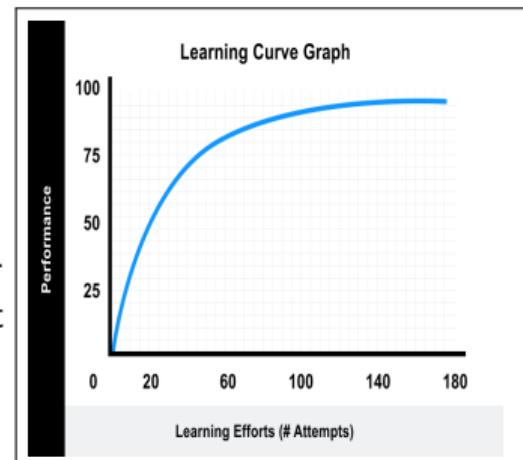


Figure: Learning Curve

It is clear **active learning** is very vital in research

How to read or initiate understanding by reading papers?

- How to read a paper? How to read a group of papers?

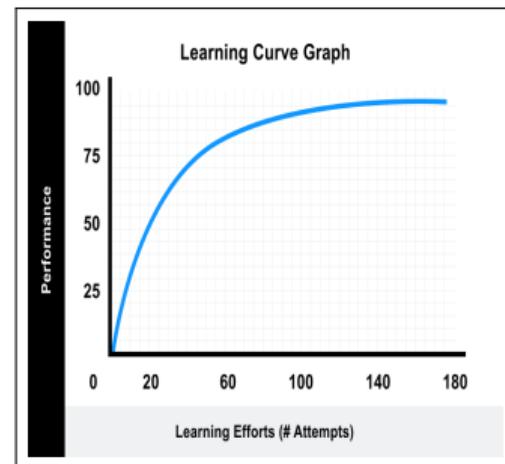


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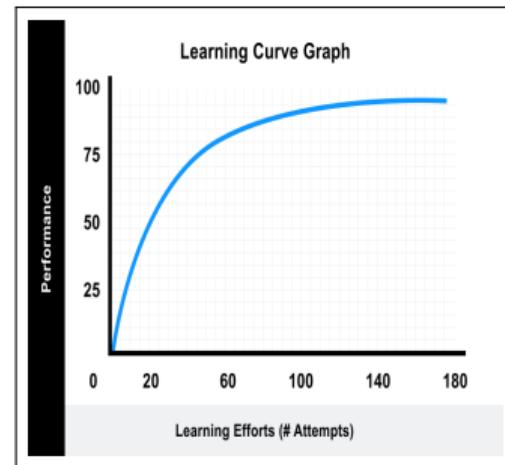


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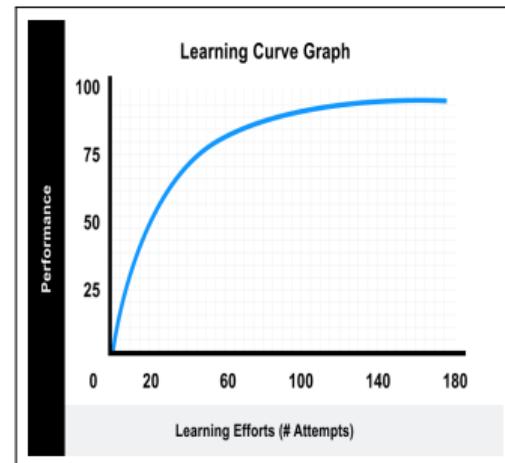


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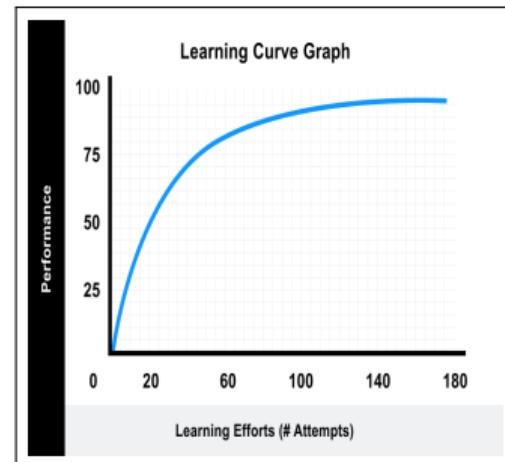


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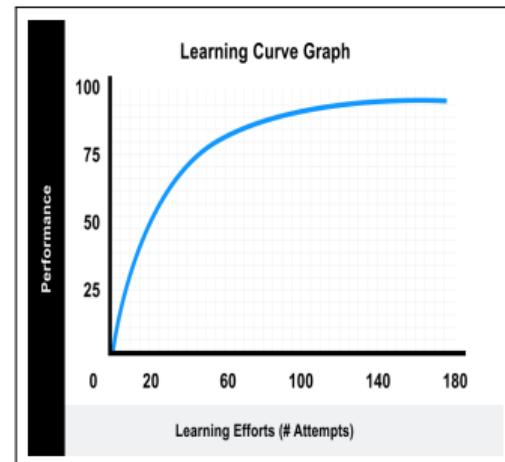


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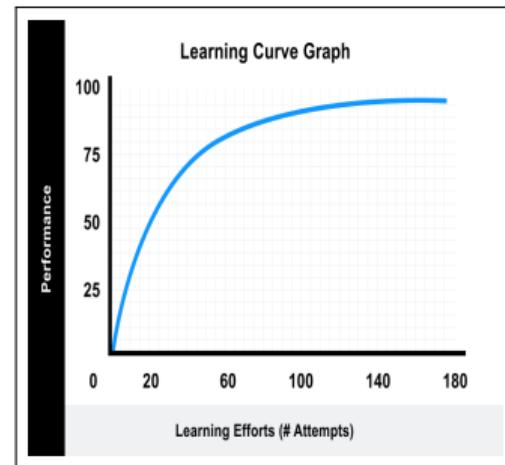


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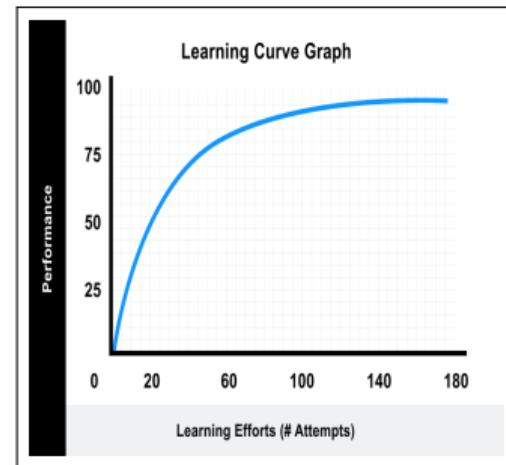


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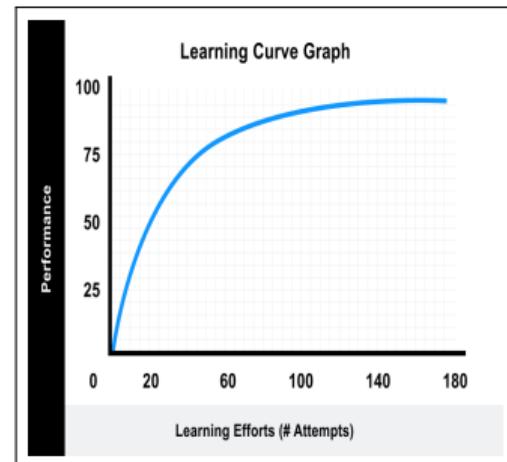


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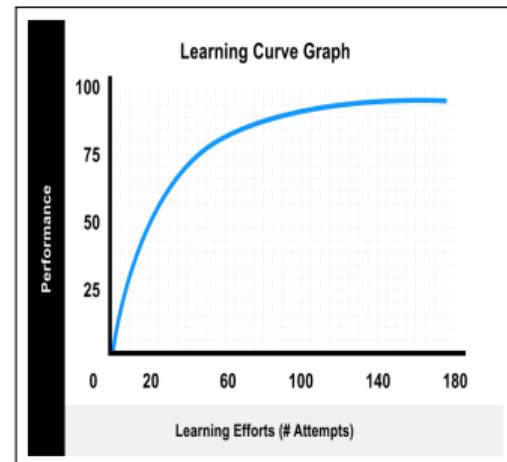


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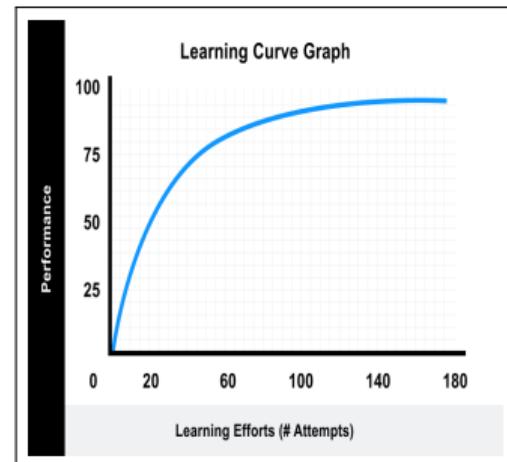


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How to read or initiate understanding by **reading papers?**

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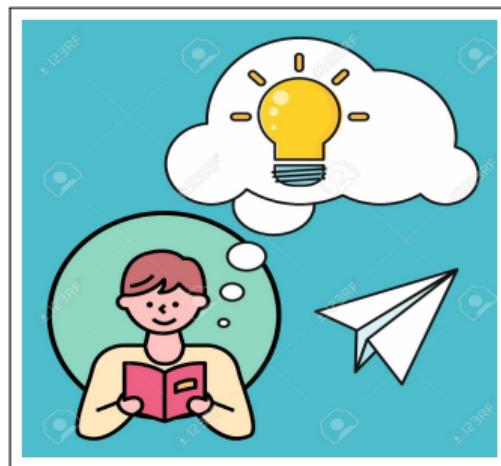


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How to read or initiate understanding by **reading papers?**

- Form strong opinions and beliefs
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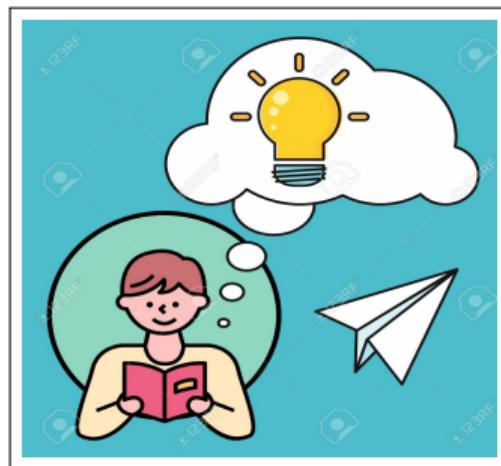


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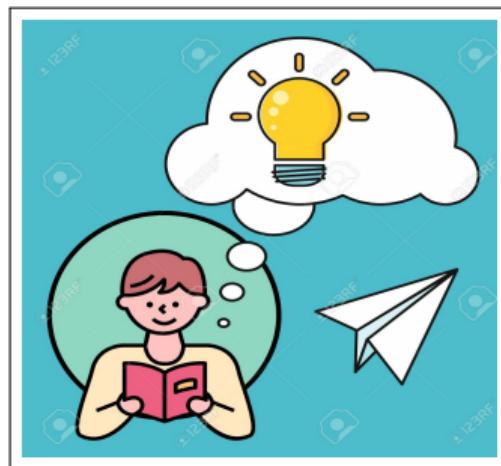


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- Requires lot of accompanied writing, ability to take notes, writing a critique.....



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Improving the learning curve

- Acquire the ability to connect different areas.

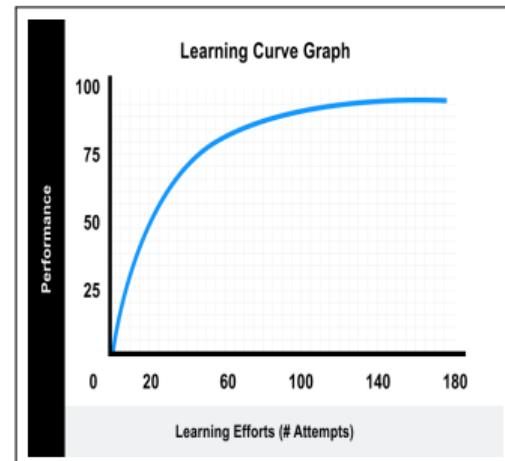


Figure: Research Process

Improving the learning curve

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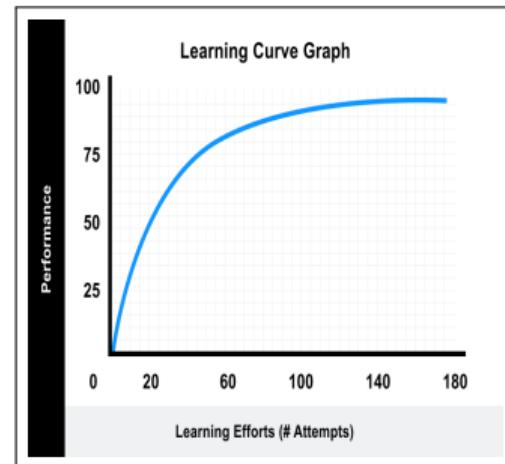


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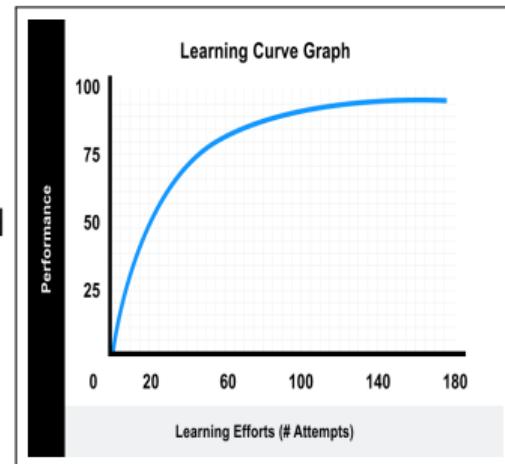


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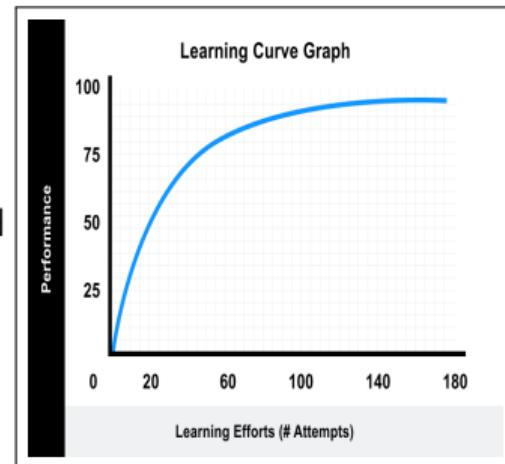


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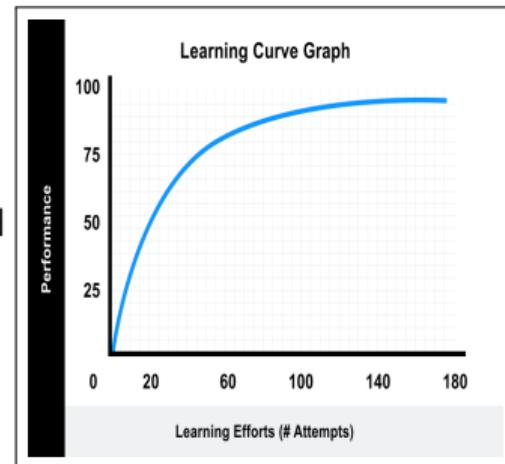


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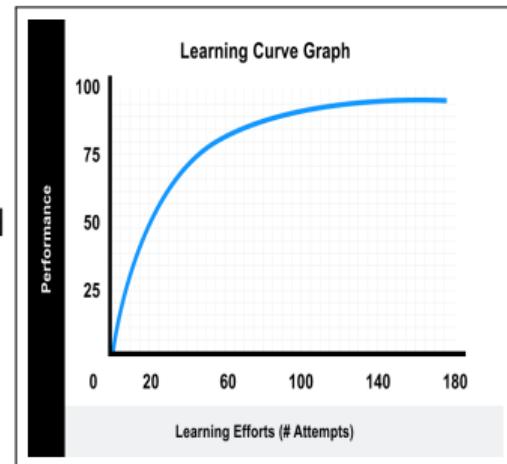


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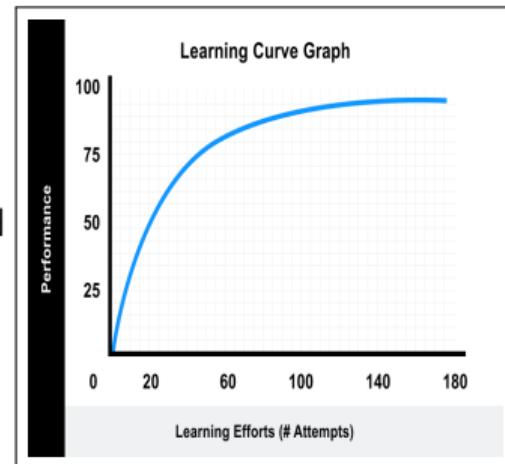


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- **Continued learning:** combining learning with the other phases of research.

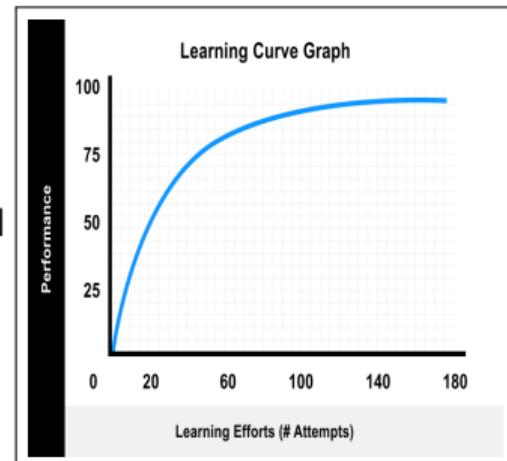


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How to find a new research problem ?

Looking for problems

- Textbooks.

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 - Stated **open problems** should be seen in a broader context.

Looking for Problems...

“Don’t just read it; fight it! Ask your own questions, look for your own examples, discover your own proofs. Is the hypothesis necessary? Is the converse true? What happens in the classical special case? What about the degenerate cases? Where does the proof use the hypothesis?”

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 - Produces a tool or a result which has direct implications to your subject.
 - Requires being abreast of related subjects/areas/topics.

Asking Questions...

“one should be unafraid to ask “stupid” questions, challenging conventional wisdom on a subject; the answers to these questions will occasionally lead to a surprising conclusion, but more often will simply tell you why the conventional wisdom is there in the first place, which is well worth knowing.”

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Say, in the field of health: questions likely asked by a healthcare professional

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- Why do some people have a particular condition whereas others do not?
- What is the average cost of a service to a patient?
- What is the ideal population-worker ratio for this programme?
- What are the health needs of the community?
- What are the benefits of this programme to the community?
- How do I demonstrate the effectiveness of my service?
- Why do some people use the service while others do not?
- What do people think about the service? How satisfied are patients with the service?
- How effective is the service? How can the service be improved?

Is there any new knowledge gained as a result of answering these questions?

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Say, in the field of business intelligence & marketing: questions likely asked by a professional

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- hence, the premise is that it is acceptable to have some **bounded unsortedness** in the result.

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 - Approach for verification, specification,..

Next section in Chapter 1: The Research Process

In the next set of slides...to be continued

B l a n k