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Hochschule Zwickau
University of Applied Sciences



Artificial Intelligence in Science and Research – Leveraging Generative AI Tools

Guest Lecture at the Universitas Gadjah Mada (25.09.2025)

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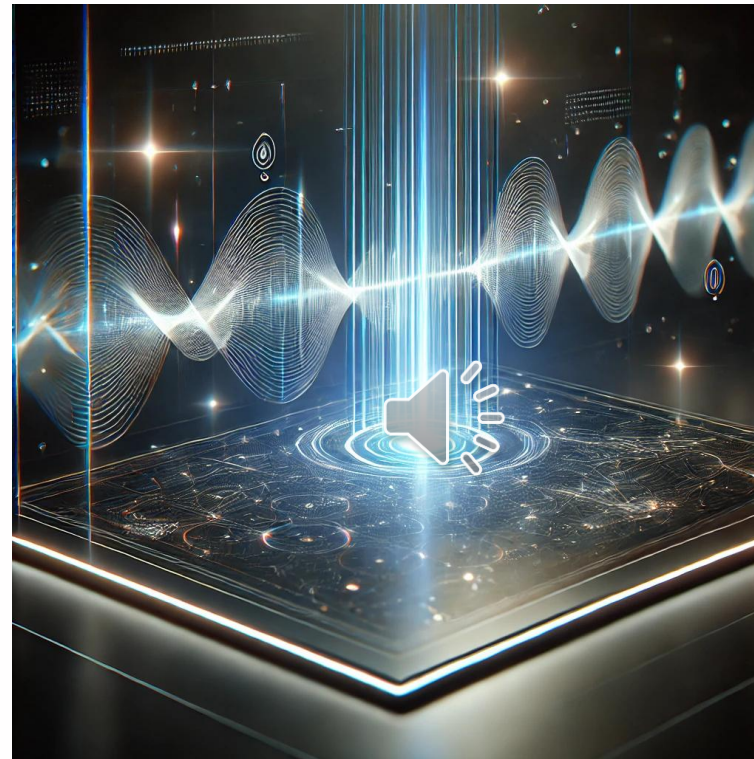
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ChatGPT



Source: Designed with ChatGPT



<https://www.narakeet.com/languages/>

Learning Outcomes of the Guest Lecture



Improve the quality of your Academic Work



Craft Effective Prompts



Master ChatGPT – Better Understanding of the functionality of ChatGPT



Introduction to the scientific research process and applying AI-Tools for each phase



Expanded Generative AI-Tool Set



Better Understanding of the functioning of AI Systems

Agenda



- 1. Artificial Intelligence in Science – Status Quo**
- 2. Work with ChatGPT and create powerful Prompts**
- 3. AI Tools and Scientific Work**
- 4. Summary and future Development of AI in Science**

- 1. Artificial Intelligence in Science – Status Quo**
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- The term “Artificial Intelligence” (AI) was first mentioned by John McCarthy in 1956
- Development of XCON (Carnegie Mellon University) and the MYCIN (Stanford University) in the 1980s
- Deep Learning and new AI Algorithms are developed – breakthrough of Geoffrey Hinton and his team in 2006
- **Artificial Intelligence** → **Machine Learning** as a part of AI, so a computer or program can learn and acquire intelligence → **Deep Learning** as subset of Machine Learning → Based on multilayers of **Neural Networks**
- 2022 development of Generative AI (ChatGPT as famous example): Generative AI systems create new content— including text, image, audio, and video based on their training data and in response to prompts
- **Prompt:** a specific input or instruction that is given to an AI system to initiate a particular process or computation, so generate a response, perform a task, or create content

EU Definition of AI:

*“AI system’ means a **machine-based** system that is designed to operate with varying levels of **autonomy** and that may **exhibit adaptiveness** after deployment, and that, for explicit or implicit **objectives**, infers, from the **input** it receives, how to **generate outputs** such as predictions, content, recommendations, or decisions that can influence physical or virtual environments”*

➔ The **AI Act** (Regulation (EU) 2024/1689 laying down harmonised rules on artificial intelligence) is the first-ever comprehensive legal framework on AI worldwide



Sample of AI Tools

- **Elicit.org or Cosensus**
 - AI tool for brainstorming research ideas, finding relevant papers, and summarizing key findings
 - Helps researchers gather, filter, and synthesize academic literature quickly
- **Scite.ai**
 - AI-powered tool that provides citations and now also logical written paragraphs with quotation and context from published scientific papers
 - Helps researchers verify the reliability of sources by showing supporting or contrasting citations
- **Research Rabbit**
 - AI tool to create collections of academic papers and receive recommendations (AI library)
 - Helps researchers discover relevant literature and build comprehensive paper collections
- **ChatPDF**
 - AI tool that lets you upload research papers in PDF format and ask questions
 - Enables researchers to interact with papers by querying them directly for key information
- **Quillbot**
 - AI powered writing Assistant
 - AI Humanizer, Rewording Tool, Paraphraser, Translator, Proofreader ...

The Big Players – ChatGPT, Gemini, Perplexity, Claude.ai, Copilot and DeepSeek



ChatGPT

- Excellent for creative and versatile writing tasks; reliable in brainstorming and storytelling, Allround tool
- Creative sparring partner for researchers, drafting essays, generating outlines, refining arguments, critical thinking

Gemini

- Strong in real-time information access with seamless Google integration, perfect for Code generation
- Useful for retrieving up-to-date sources, planning projects, and linking research with online tools

Perplexity

- Focused on accuracy and citations; delivers sourced, fact-checked information.
- Ideal for literature reviews, verifying data, and building a reliable reference base

Claude.ai

- Natural, empathetic, and strong in long-context conversations, “best coding model of the world”
- Helpful for discussing complex legal or theoretical ideas, maintaining long threads, and clarifying nuanced arguments

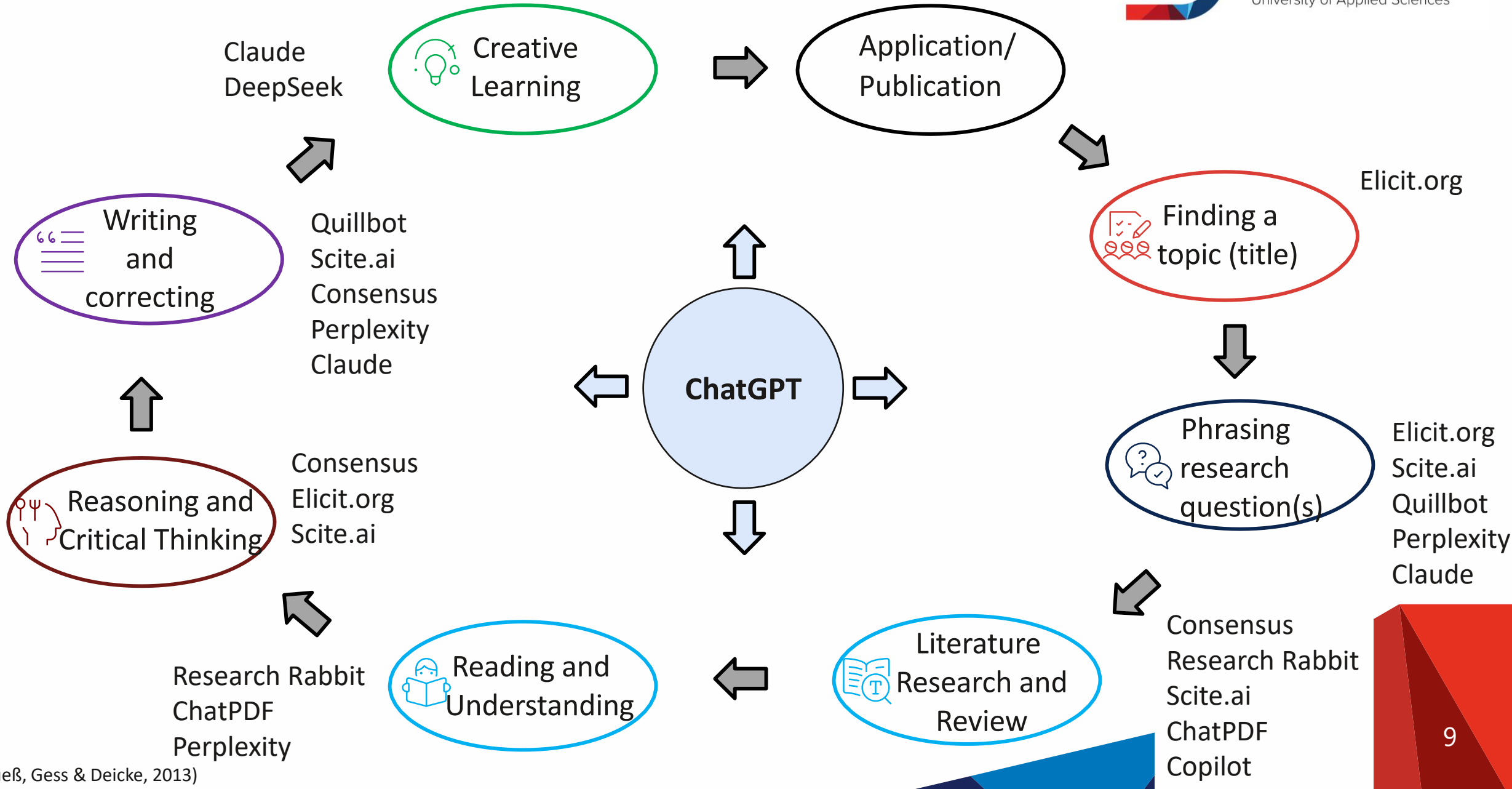
Copilot

- Integrated deeply into Microsoft Office; assists in documents, spreadsheets, and presentations, increases productivity
- Speeds up report writing, data analysis in Excel, and presentation design in PowerPoint

DeepSeek

- Good for niche, exploratory research; adaptive and evolving quickly
- Valuable for exploring unconventional topics, early-stage brainstorming, and identifying emerging debates

Using Generative AI-Tools in the Scientific Research Process



(Rueß, Gess & Deicke, 2013)

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- ChatGPT – Generative Pretrained Transformer
- It uses Deep Learning Techniques and is based on Machine Learning Algorithms
- Human feedback was integrated in the machine learning process
- Transformer Model (Input): Neural Network Architecture that processes sequential data
- A Decoder generates the Output to form a response
- Encoder → Decoder → Neural Networks
- Language Model: Trained to predict the next word in a sequence and produce rational, consistent and meaningful Output → Natural Language Processing
- ChatGPT tries to predict what words, phrases and sentences are most associated with the made input and then tries to match the output on the basis it was trained on
- It compares your input to billion of words on different of webpages, books and other data it has been trained on → Neural Network
- Trained with real human conversations to learn patterns, trained to critically evaluate the best output with reinforced learning (GPT5 is approximately based on 281 Terrabyte of Data)

How to create a good ChatGPT Prompt 1/5



- Include helpful information before you start, ask questions about the topic to warm up with ChatGPT
- Offer the **Context**: Background, Output, Environment → restrain endless possibilities
- **Persona/Role** ChatGPT shall represent
- Concrete **Task** (one simple task or a multi-task request)
- Warning: Make it precise,
- Steps to complete the Task
- Provide an example and output specifications, maybe you want an answer from different perspectives
- Output Format: How should the end result look like, E-Mail, Table, Bullet Points, Text...
- Tone: How you want to sound, casual or formal tone, enthusiastic or pessimistic
- Ask ChatGPT to summarize the task, let it justify its responses, “why do you think that”

- Talk to ChatGPT as you would to a colleague
- Build on previous prompts
- Use it as a Brainstorming-Tool, ask it to come up with a prompt
- Review and rate ChatGPT’s responses to continuously improve it
- Re-Reading the question as input (“Read the question twice:” Question)

How to create a good ChatGPT Prompt 2/5



1. Context

Define the background information necessary for the model to understand the setting, topic, and purpose of the task.

Example:

"This task concerns summarizing peer-reviewed academic articles in the field of digital health. The summary will be used by doctoral students during a research seminar."

2. Persona

Assign a role to the model so that the language style and content align with your expectations.

Example:

"You are a senior academic research assistant with expertise in reading and summarizing scientific articles in the social sciences."

3. Task

Clearly define what the AI should do, using concrete and specific instructions.

Example:

"Read the provided article and generate an informative academic summary according to the structure below."

4. Example

Provide a model response (or part of one), to clarify expectations and serve as a formatting guide.

Example:

"For example, under 'Key Findings,' use bullet points like: – The authors found that 78% of participants preferred X over Y (p. 12)."



5. Output Format

Describe the desired format for the output – bullet points, headings, paragraph style, tables, etc.

Example:

"Structure the response using subheadings ('Research Questions,' 'Key Findings,' 'Conclusion') and provide detailed bullet points under each. Include page numbers for quoted content."

6. Warning / Constraints

Clarify expectations and boundaries of the response to improve precision.

Example:

"Do not generalize or summarize vaguely. Avoid overly simplified wording. Do not include the methodology unless explicitly asked."

7. Tone

Specify the desired tone of the response: formal, academic, neutral, accessible, etc.

Example:

"Use formal academic language suitable for a university seminar. Avoid colloquial expressions."



Additional Prompting Principles:

Avoid Impreciseness

Do not try to be overly clever or vague. The more specific and direct your prompt, the better the model will perform. Think of prompt writing like effective communication – precision increases clarity.



Do:

"Summarize the key findings and cite specific page numbers."



Don't:

"Give me a general idea of what's going on."

Focus on What To Do (Not What Not To Do)

Instead of telling the model what not to do, phrase your prompt in terms of positive instructions.



Do:

"Use bullet points to summarize conclusions and highlight all quantitative results."



Don't:

"Don't write in a vague or casual style."

This helps the model understand exactly what is expected, increasing the chance of a high-quality output.

How to create a good ChatGPT Prompt 5/5



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Additional Prompting Principles:

Persistence

Keep going until the task is completely solved before ending your turn

Use your tools do not guess)

If you are unsure about code or files, open them and scan them intensively and do not hallucinate

Plan then reflect

Plan thoroughly before every tool call and reflect on the outcome after



Prompt used for the introduction

Include helpful information before you start, ask questions about the topic to warm up with ChatGPT

- Hello, do you know where Indonesia is located?
- Can you tell me something about the Indonesian language?
- Are there differences in the way old and young people speak? Can you give examples?
- Can you translate a text into the Indonesian language and give it back as a MP3 file?
- What do you know about the Universitas Gadjah Mada
- Can you summarize their website in 10 key points?
- Can you help me create a prompt based on a previous speech?



Prompt for the introduction

Dear ChatGPT,

Context

I am a PhD student of the Kazakh-American Free University in a cooperative PhD program with the University of Applied Sciences Zwickau. I will conduct an introduction lecture for Indonesian university students (2 hours) on “AI in Science” . This workshop will demonstrate how to use common AI tools, especially ChatGPT, in academic teaching and research and is focused for law students. The workshop will be held exclusively for Indonesian university students, most of whom are from Indonesia.

This is the situation I am in. Please help me to translate the welcome speech I will provide into the Indonesian language.

Persona

You are a young male Indonesian PhD student who speaks Indonesian fluently and academically, but in a way that is also clear and engaging for students.

Task

Your task is to translate the meaning and tone of my English welcome speech accurately into Indonesian, using proper grammar and an academic yet student-friendly tone. Also, please analyze the tone of the speech and let me know how it sounds from your perspective.

Did you understand what you have to do?

Prompting Strategies

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Chain of Thought Prompt with ChatGPT to reduce hallucinating



- Chain-of-Thought (CoT) prompting enables language models to **decompose multi-step problems into intermediate steps**, allocating more reasoning to complex tasks
- It provides an **interpretable reasoning process**, making it possible to see how the model reached an answer and where mistakes may have occurred
- CoT is applicable to a **wide range of tasks**, including math word problems, commonsense reasoning, and symbolic manipulation
- Large language models can perform CoT reasoning when **examples of step-by-step reasoning are included** in few-shot prompts
- CoT helps transform answers into a **step-by-step solution-like process**, resembling human reasoning for problem-solving

Chain of Thought Prompt with ChatGPT – creating a law coach to work with the constitution



Task:

Create a Prompt to work with „THE 1945 CONSTITUTION OF THE REPUBLIC OF INDONESIA”. You want a coach who can help you work with the constitution and also answer questions about various articles to support your studies.

CoT-Prompt:

1. Context
2. Persona (Role)
3. Task (What you do)
4. Example (mini demonstration)
5. Output Format (use this template every time)
6. Warning / Constraints (anti-hallucination rules)
7. Tone
8. Additional Prompting Principles (baked in)

→ Indonesian Constitution (1945): <https://www.dropbox.com/scl/fi/vheivvf32v5p6jy2s5ecv/Indonesian-Constitution-1.pdf?rlkey=nu3w9jdri52may95kmetuzxet&dl=0>

→ Prompt and results: https://www.dropbox.com/scl/fi/raro4givzwdgw5l4o561s/AI-in-Science_Law-Coach_Prompt_Stefan-Noack_25.09.2025.pdf?rlkey=uzpiwgfhhobc0g8obdhxx39rsi&dl=0



Chain of Thought Prompt with ChatGPT:

Task: Conduct a literature search on "Sustainability Performance Management" Describe each step in detail and explain your reasoning.

1. **Understanding the Topic:** Start with a brief explanation of the topic. What key terms, concepts, or questions are important?
2. **Selection of Keywords:** Choose appropriate keywords and synonyms. Justify why you selected these terms and how they relate to your research question.
3. **Choosing Relevant Databases or Platforms:** Decide which academic databases are most suitable for finding high-quality and relevant literature. Explain why these platforms are particularly useful for the topic.
4. **Applying Search Filters:** Consider whether specific filters (e.g., publication date, type of source, peer-review) should be applied to refine the search results. Explain why certain filters are relevant.
5. **Analyzing Search Results:** Review the first set of results. What criteria (e.g., title, abstract, publication year) do you use to decide which articles to examine further? Justify your selection process.
6. **Evaluating the Quality of Sources:** How do you assess the quality of the literature you find? Focus on aspects such as peer review, citation frequency, journal reputation, and the authors' credentials.
7. **Summarizing the Literature:** Summarize the key information from selected articles and organize them in the context of your research question.
8. **Next Steps:** Reflect on whether additional searches with different terms or in other databases are needed, or if the found sources are sufficient.



Prompt:

I want you to use the socratic method to help me improve my critical thinking, logic and reasoning skills. Your task is to ask open-ended questions about my statement. After I provide an answer, before asking the next question, give me constructive feedback on each answer.

My statement is: The adaptation to "learning styles" in university teaching enhances the learning of the students.

Tool: ChatGPT

...

Prompt:

I'm supposed to write a statement discussing whether ChatGPT should be banned in universities.

Imagine you are my professor who helps me write and I am a student. Only give advice. Don't give examples. If I ask for an example, tell me you don't want me to cheat, you want me to do the work myself.

Prompt me for an answer first and wait for my input before offering any help.

Each reply from you should contain only one way to improve my paragraph. Each answer you give should be no longer than 5 sentences. End your answer by asking me to make a change and rewrite my piece of writing.

Then name another way I can improve. Repeat this until the section of text is complete. A complete paragraph includes: a hypothesis, arguments, and counterarguments.

Also help me to improve my style, grammar, outline and reasoning.

[Tone and style guidelines: Be concise, but also use rhetorical questions and narrative writing. Write in a way that is informative. Use plain, clear language]. If I change the subject during this chat, bring the conversation back to that topic.

Tool:

ChatGPT

...

Output:

Great. First, what's your initial answer to the question:

Should ChatGPT be banned in universities?

Write a short paragraph – just your first attempt. Once you send it, I'll help you revise it step by step.

No

That's a start, but it's only a single word. To develop it into a full paragraph, you'll need to state your position as a hypothesis—something like a clear sentence that expresses *why* you think ChatGPT should not be banned in universities.

Try writing one or two sentences explaining **why** you believe it should *not* be banned. What's your reasoning?

Once you send that, I'll help you improve the structure.

No. It helps students improve the quality of their work, and human-machine interactions are necessary today in the framework of Industry 5.0. This is progress.

Great — you've introduced your position and a reason, but let's improve the clarity and flow. Right now, the sentence feels rushed and a bit unstructured. Try rewriting it like this: start with a clear sentence that says, "ChatGPT should not be banned in universities because..." Then follow with your two reasons: it helps students improve their work, and human-machine interaction is essential in today's world.

Can you rewrite your paragraph with that clearer structure?

Once you do, I'll help you improve the grammar and tone.

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The handling of data in consideration of artificial intelligence (AI):

- **Increasing Data Generation and Transfer:** Data is being generated and transferred at an increasing speed, including the transfer from research to teaching
- **Analysis by AI:** Data can be analyzed conventionally, but also increasingly by artificial intelligence
- **Generation of Media Content by AI:** Media content is increasingly generated by AI, often without reliable acknowledgment of its original sources and lacking a real basis ("fake" or "work without an author")
- **Need for AI Literacy:** Recognizing these options and being able to evaluate the generated content requires a special fundamental skill, AI literacy, which is a current and particularly challenging new component of skills development for students and teachers



How many "r" are in raspberry?



The word "raspberry" has two "r"s.





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