

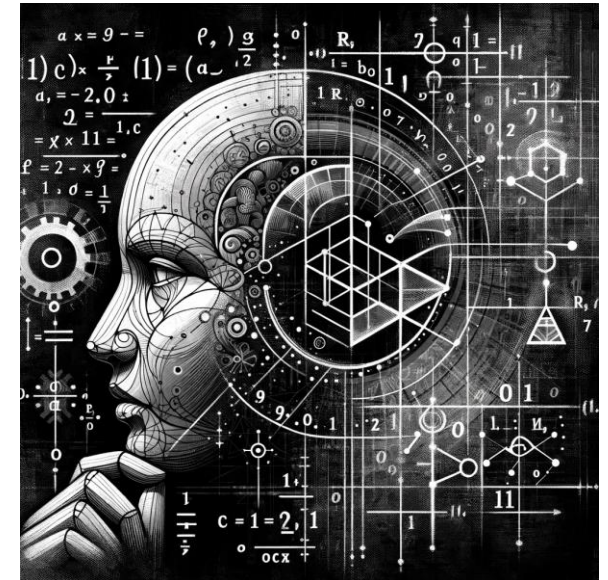
ICSE Academy

STEM in the Digital Era Session 1, Digital Competencies, Skills and Technology in STEM Fields



The Structure of the Module

- **7.5.2024** Digital Competencies, Skills and Technology in STEM Fields
- **14.5.2024** Escape Games in STEM-Education & VR Digital
- **21.5.2024** Computational Thinking





Overview

1. Introduction
2. Technology in integrated STEM-Education
3. Digital Skills and Competencies in STEM-Education
4. Basic Examples
5. Integrating AI in STEM-Education
6. Homework





Introduction: Who am I?

Name: Oliver Straser

Profession: Mathematician

Where do I work? International Centre for STEM – Education as „Assistant Director“, researcher and lecturer.

Main interests: Trend-analysis in STE(A)M-Education, statistical analyses, applications of 3D-Printing in STE(A)M-Education, Escape Games, AI in STEM Education:





Introduction

Learning Goals: Today you should learn...

1. Why do we need a competence and skill-focused STEM education?
2. What are digital competencies and skills?
3. How do we incorporate competency and skill-development in STEM-teaching?
4. How to use AI-based tools in STEM-teaching!



Technology in Integrated STEM-Education

Why do we need STEM Education at all?

- **Problems of the 21st Century** (Climate Change, sustainability, energy problems, overpopulation, information warfare, AI, etc): These are all STEM-related problems.
- **Scientific progress**
- **STEM labour shortage:** At least for the MOST STEM sciences
- **Economy:** Several Studies claim to show that effective STEM-education has a positive effect on the economy (GDP)

Also: STEM competencies are needed in many non-STEM fields



Technology in Integrated STEM-Education

Also: STEM competencies are needed in many non-STEM fields

Examples:

- Art & 3D Printing
- Archeology & Laserscanning
- Automated woodworking
- Food Design (Bubble Tea)





Technology in Integrated STEM-Education

STEM Education is an acronym (Science, Technology, Engineering, Mathematics)

- Science is a container (Biology, Chemistry, Physics and more)
- In this definition there is no connection between these different disciplines

What do STEM sciences have in common?

- Problem solving
- Quantitative reasoning (except math ;-))
- Critical thinking
- Scientific method
- Interconnectedness



Technology in Integrated STEM-Education

Some facts

- Since the 2000 especially since 2010 STEM education is a central point of educational efforts to improve the educational system
- The Terminology STEM is attributed to National Science Foundation (NSF) in the United States. The term 'STEM' itself was coined relatively recently. It is generally attributed to Judith A. Ramely,
- The NSF's definition of STEM fields includes mathematics, natural sciences, engineering, and computer and information sciences to incorporate social and behavioural sciences in an interdisciplinary way



Technology in Integrated STEM-Education

Why integrated STEM Education?:

"Real-life problems do not conform to specific subject boundaries."

But: Significant debate surrounded the ideal framework for STEM education within the scientific community.

- Collection of independent subjects
- Inter/Multi/Transdisciplinary approaches
- Integrated STEM was introduced to separate both views

Roughly:

Integrated STEM learning combines the subject matter of one or more STEM subjects into a joint learning experience with another subject (which topic is not necessarily in STEM)



Digital Skills and Competencies in STEM-Education

21 Century Challenges (among others)

- Climate Change
- Rapid technological development (for example AI)
- Informational warfare
- Health
- ...

Lopez-Claros, A., Dahl, A., & Groff, M. (2020). Global Governance and the Emergence of Global Institutions for the 21st Century. Cambridge: Cambridge University Press. doi:10.1017/9781108569293





Digital Skills and Competencies in STEM-Education

- All those challenges require an interdisciplinary perspective
- All those challenges require the use of technology
- All those challenges require problem solving abilities

So, we need a competence-oriented approach to STEM-learning





Digital Skills and Competencies in STEM-Education

21 Century Skills

- scientific reasoning
- evidence collection
- critical-thinking, problem-solving, analytical thinking
- communication

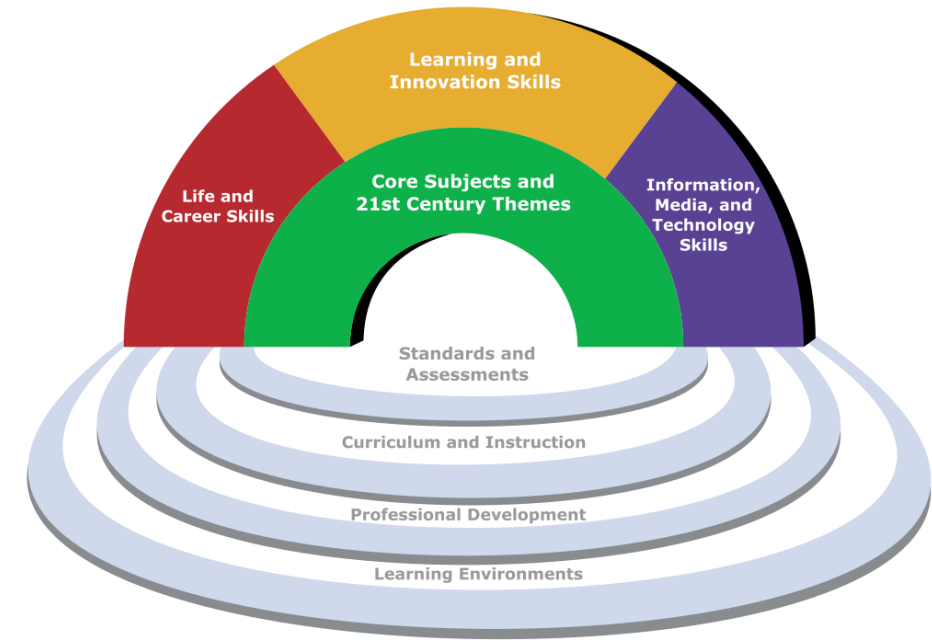


Figure 1 - P21 Framework for 21st Century Learning

Charles Fadel and Krishna Chaitanya Velaga,
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Digital Skills and Competencies in STEM-Education

How the world of work has changed in the recent years

- Machine operators -> Use of CNC
- Electricians -> Smart homes
- Farmers and Agricultural Workers -> automated systems and drones
- Automotive Workers: electronic diagnostics and computer-based analysis





Digital Skills and Competencies in STEM-Education

How the world of work has changed in the recent years (in non-STEM fields)

- **Fashion Designers:** computer-aided design, and smart fabrics,.
- **Cooks and Chefs in Commercial Kitchens:** digital inventory tracking, basic automation in cooking processes.
- **Security Guards:** Use of surveillance technology, digital reporting systems, drones.



Digital Skills and Competencies in STEM-Education

How the world has changed in the recent years (especially for students)

- Everyday Life (living, communicating learning, free-time)
- Societal implications (presentation, online behaviour)
- legal implications (identity theft, harassment)





Digital Skills and Competencies in STEM-Education

Concrete example Roblox

- Online game with “simple” graphics
- Collaboration with other in small games (fighting, building, problem solving)
- In-game currency to buy content social items, weapons)
- In game currency can be earned by
 - Producing own games (coding)
 - Own social items (3D-design with blender)
 - Trading or stolen by hacking





Digital Skills and Competencies in STEM-Education

We use the Framework of Key Competencies for Lifelong Learning

Digital Competencies

- Knowledge
- Skills
- Attitudes



Working group:
mixed countries



Basic Examples

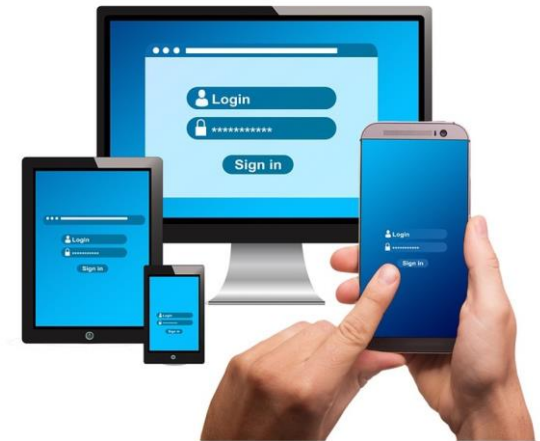
Very basic example 1: What is a good password?

If you want to write emails, post something in a social network simply order something online, you always have to log in with your own username and password. For every email account every social network and every online store you need your password, and it should be as secure as possible!

But why is it important to use secure passwords and what does a secure password actually look like?

<https://www.teach4life.eu/competence/technology/authentic-context>

- What competencies (knowledge, attitudes, skills) could be developed with this task?





Digital Skills and Competencies in STEM-Education: Examples

Knowledge

- Supporting Communication and Creativity
- Opportunities and Limitations
- Understanding Technology
- Critical Approach to Information
- Legal and Ethical Principles

Examples:

- How does a search engine work?
- Do not believe everything you read in social media (even if it sound plausible)
- What sources am I allowed to use and share (for example copyright issues)





Digital Skills and Competencies in STEM-Education: Examples

- **Skills:**
- Supporting Active Citizenship and Social Inclusion
- Collaboration and Creativity
- Comprehensive Digital Literacy
- Information and Data Management
- Engagement with Advanced Technologies

Examples:

- Coding
- Use of 3D-Printers
- Evaluate online resources





Digital Skills and Competencies in STEM-Education: Examples

Attitudes:

- Reflective and Critical Approach
- Curiosity and Open-Mindedness
- Forward-Looking Perspective
- Ethical Use of Technology
- Safety and Responsibility

Examples:

- Do not post compromising photos of others online
- Willingness to use digital signatures



Basic Examples

Very basic example 2: Self driving cars?

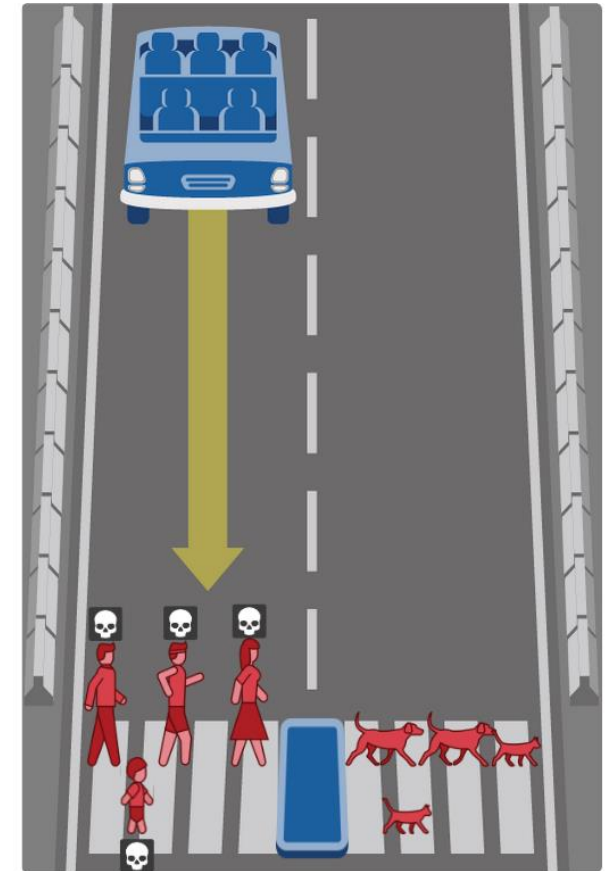
Even though it is not yet permitted in many countries to drive cars completely autonomously, self-driving cars are becoming increasingly popular. Reports about fatal accidents with autonomous driving vehicles are always present in the media, but the car industry promises that in the near future autonomous driving systems will be in no way inferior to human drivers in terms of safety.

However, even if autonomous driving systems are safe, there may be situations where accidents are unavoidable. What rules should an autonomous driving car then follow

<https://www.teach4life.eu/competence/technology/authentic-context>

- What competencies (knowledge, attitudes, skills) could be developed with this task?

Working group:
mixed countries

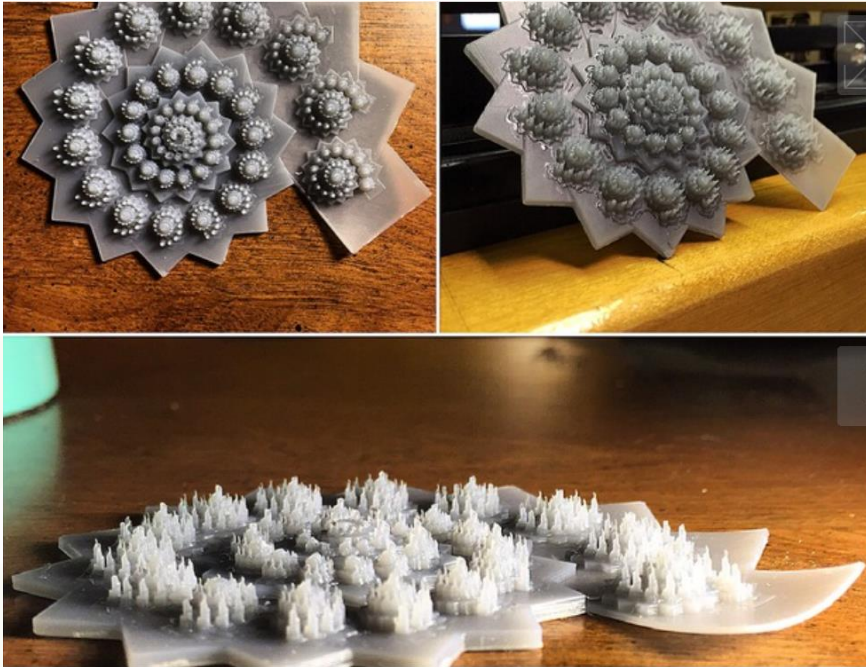




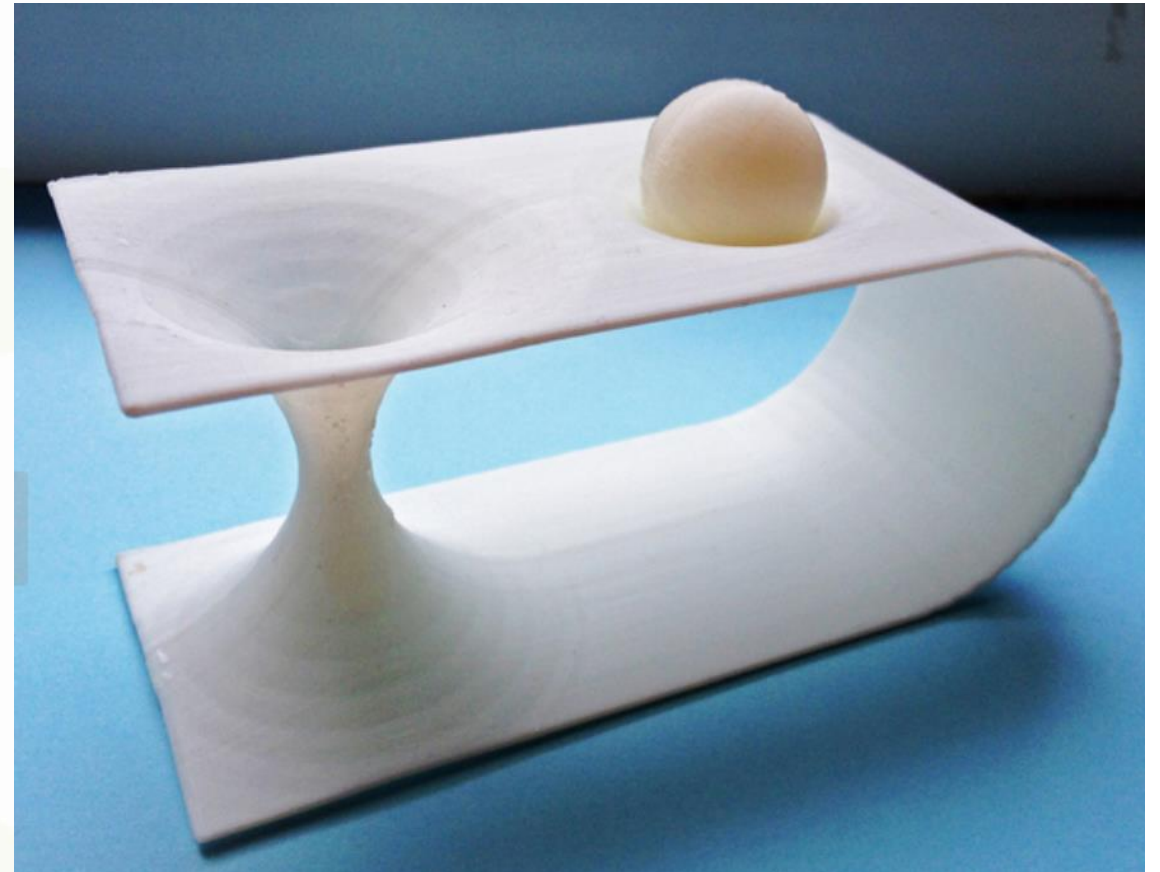
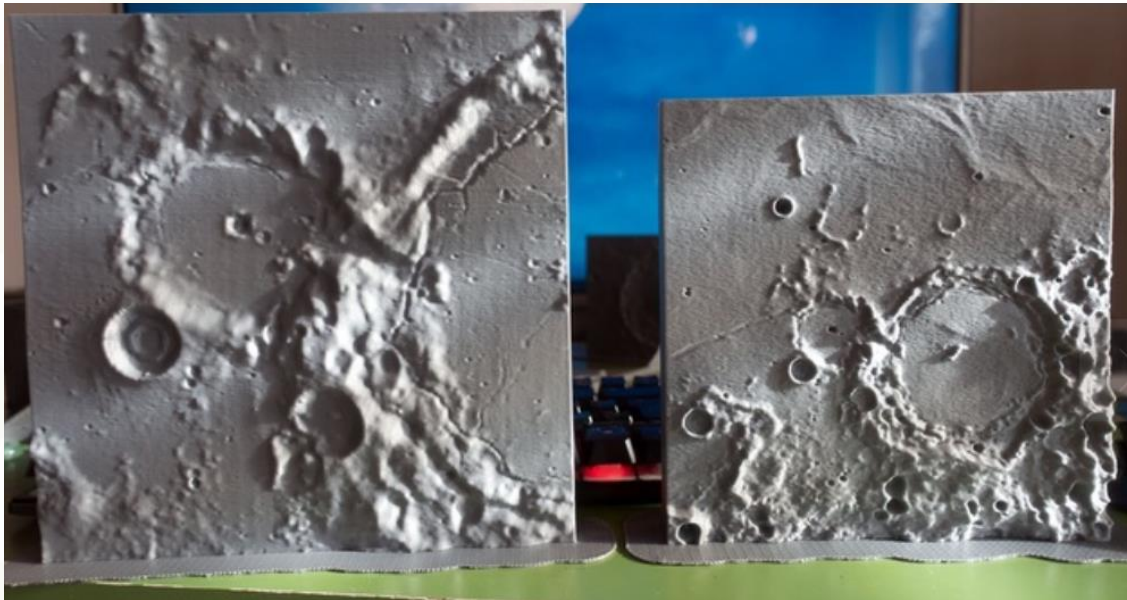
Example 1: 3D-Printing in STEM Education



Applications of 3D printing in the school sector



...or astronomy



Experiment: Cooking soap

- Personalized soaps possible
- Primary school/lower school: pouring glycerine soap
- Middle/upper school: "Classic soap making"
- Quality market level possible
- Well suited for project days/classroom settings



Experiment: Bath bombs

- Easily possible from elementary school.
- Adjustable in size, much more robust than purchased molds
- Source: Chemical trade, e.g. [omikron - natural products and fine chemicals \(omikron-online.de\)](https://www.omikron-online.de)



Summary: Digital Competencies and 3D-Printing:

Knowledge

- Understanding how 3D-Printing works
- Design Principles and CAD Software
- Material Properties
- Printer Maintenance and Troubleshooting:

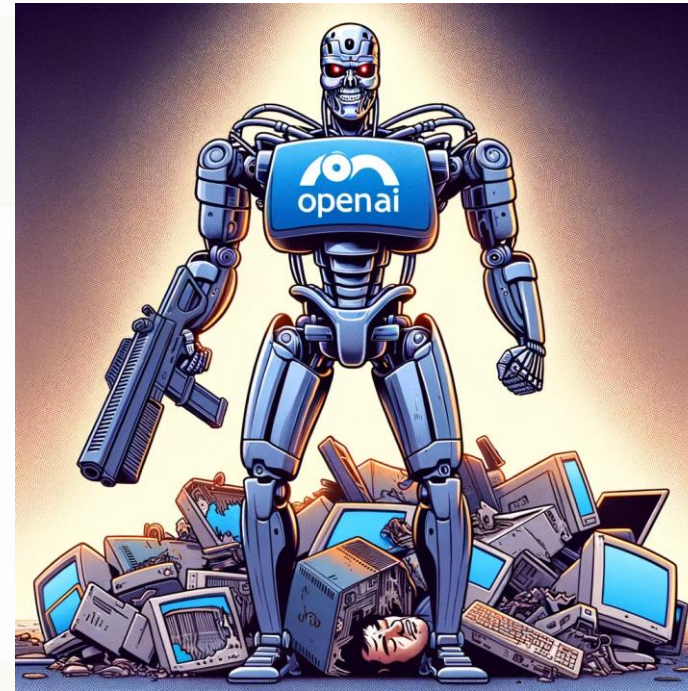
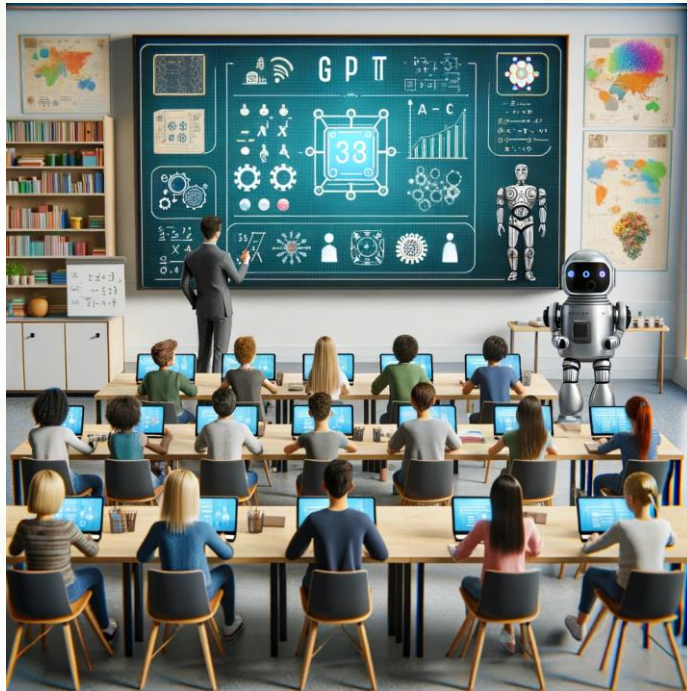
Skills

- Design and Modeling Skills
- Printer Operation
- Critical Thinking and Problem-Solving

Attitude

- Ethical and Responsible Use.
- Persistence and Patience.

AI in STEM Education



Wh?

The situation in schools is dire

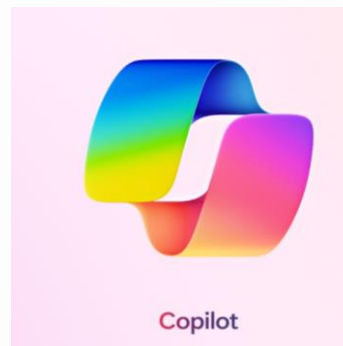
1. Teacher shortage
2. High workload for teachers
3. Diversity & Inclusion
4. Individual support
5. Rapidly changing STEM-content

-> AI tools have the chance to reduce the workload!!!



AI Tools in STEM Education

So, there are a lot of AI tools for STEM Education...



AI Tools in STEM Education

But we focus on GPT-because...

1. It is ready to use
2. It is easy to use
3. It is extremely powerful (if used correctly)
4. It has a cost-free basis variant



AI Tools in STEM Education

GPT Versions

1. GPT 3.5 (cost free, accessible under <https://chat.openai.com/>)
 - Great for simple tasks
2. GPT 4 (free for Microsoft 365 users)
 - More precision than 3.5
3. GPT Pro (v4.) for 20\$/Month as GPT Pro
 - Can process uploaded documents
 - Can be individualized
 - Can produce pictures

Note: There are also variants (GPT4 Turbo) and variants of GPT that are able to process larger data sets at once via API (*Application Programming Interface*)



AI Tools in STEM Education

So, what will we do concretely?

1. Show some examples on how to use GPT in STEM education
2. Provide you with a “cheat sheet” of best prompts (appendix)
3. Give you a download link for the slides at the end of the workshop (appendix)
4. Provide you with references (appendix)



AI Tools in STEM Education

And we WON'T cover the following topics (even though we would love to)

1. What is an AI and how does the “learning” work.
2. Image generation
3. AI, Data Analysis and Coding (there is too much to tell)
4. Legal issues (in detail)
5. Problems concerning students using AI to solve their homework



Overview

Version	GPT 3.5	GPT 4	GPT 4 + Instruction
Speed	Fast	slow	slow
Internet Access	no	yes	yes
Analysis Capacity	Text (20 Papes)	Text (up to 50 pages), Websites, Images, Audio, Video, Office files	Text (up to 50 pages), Websites, Images, Audio, Video, Office files
Output	Text	Text, Images, Office files	
Note		Complexer Input	Can be pre-instructed, also work with special literature or work with external aids (e.g. Wolfram Alpha)

(Some) Areas of Application in STEM-Education

Assessment &
Diagnostics

Lesson planning
and
implementation

Professional
development

Administration

Individualized
Learning

Research

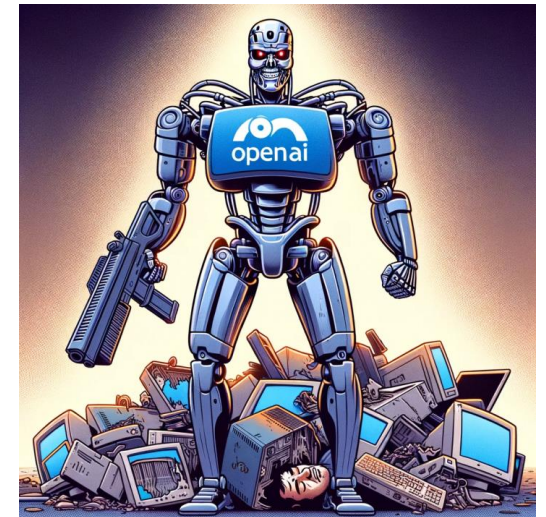
Example 1: Lesson Planing and implementation



Before we start: Some recommendations

How to chat with GPT

1. Be gentle
2. Be as precise as possible
3. Build quality assurance in your requests
4. Let GPT test its own answers (you might be surprised)



Example 1: Can GPT solve STEM Problems?

 You

If I kick a soccerball 45° in the sky and it starts flying with 40km/h. How far will it fly?

 ChatGPT

If you kick a soccer ball at an initial speed of 40 km/h at a 45-degree angle, we can calculate how far it will travel horizontally (its range) using the principles of physics. To make the calculation easier, let's convert the initial speed to meters per second:

1. **Convert speed** from km/h to m/s:

$$40 \text{ km/h} \approx \frac{40 \times 1000}{3600} \approx 11.11 \text{ m/s}$$

2. The range of a projectile launched at an angle θ with an initial velocity v is given by the formula:

$$R = \frac{v^2 \sin(2\theta)}{g}$$

where:

- g is the acceleration due to gravity, approximately 9.8 m/s².
- θ is the angle of projection (45 degrees in this case).
- $\sin(2\theta)$ becomes $\sin(90^\circ) = 1$ when $\theta = 45^\circ$.

Substituting the values:

$$R = \frac{(11.11)^2 \cdot 1}{9.8} \approx \frac{123.43}{9.8} \approx 12.6 \text{ m}$$

So, the soccer ball will travel about 12.6 meters horizontally.

Task 1:

You will work in groups:

Your Task: Use GPT to solve a STEM-related problem (you can choose your favourite one).

Discuss:

- Creativity and accuracy of AI solution
- Did you need to help GPT with the solution
- Possibilities of AI as a teaching tool.

Possible STEM Problem:

If you stack glasses one inside the other, each new glass increases the height. If a stack of 2 glasses is 23 cm high and 6 glasses are 59 cm high, how high is a stack of 3 glasses?



AI Tools in STEM Education

To use GPT for free you have 3 options:

Option 1: create an account at <https://chat.openai.com/>

Option 2: (if you have a Microsoft account) go to <https://www.bing.com/>

Option 3: (if you have a Microsoft 365 subscription)
<https://copilot.microsoft.com/>

Example 2: Lesson Planing and implementation

01. You

Please give an explanation of newtons first and second law for academics with a STEM background

ChatGPT

Certainly! Given your academic background in STEM, I'll provide a more nuanced and detailed explanation of Newton's First and Second Laws of Motion, which are foundational concepts in classical mechanics.

Newton's First Law of Motion (Law of Inertia)

Statement:

An object will remain at rest or in uniform motion in a straight line unless acted upon by an external force.

Explanation for STEM Academics:

1. **Inertia Conceptualized:** The law introduces the concept of inertia, which is the resistance of any physical object to a change in its state of motion or rest. This property is intrinsic to mass.
2. **Equilibrium Analysis:** The law implies that a body is in a state of equilibrium if it is at rest or moving with constant velocity. This can be quantified using vectors and inertial reference frames, where the net external force is zero.
3. **Foundation for Dynamics:** It sets the stage for understanding dynamics in a non-relativistic framework. The law holds true in inertial frames of reference, which are either at rest or moving at a constant velocity relative to each other.
4. **Real-World Implications:** Practically, this principle can be observed in phenomena like the persistence of motion of a satellite in orbit or the continued motion of a puck on an air hockey table (where friction is minimal).
5. **Mathematical Formalism:** In terms of Newtonian mechanics, this can be expressed as $F = 0$ when both acceleration (a) and velocity (v) are constant.

Example 2: Lesson Planing and implementation



You

Could you rephrase your text such that and 12 year old can understand this



ChatGPT

Absolutely! Let's break down Newton's First and Second Laws of Motion in a way that a 12-year-old would find easy to understand.

Newton's First Law of Motion (Law of Inertia)

What It Says:

An object will stay still, or keep moving straight at the same speed, unless something pushes or pulls it.

Simpler Explanation:

1. **Inertia - The Lazy Rule:** Imagine an object, like a ball, is lazy. If it's sitting still, it wants to stay still. If it's moving, it doesn't want to stop or change direction unless something makes it do so (like a push or a pull).
2. **Balanced Forces:** When nothing is pushing or pulling on the ball, it won't start moving by itself or stop if it's already moving.
3. **No Sudden Moves:** This law is like saying, if you're walking in a straight line and nobody bumps into you, you'll keep walking straight without speeding up or slowing down.

Example 2: |



You

Thank you. Could you produce a gap text for students (age 12) about Newton's first and second law. Also include the units that are important. (Note they already know uniform movement and evenly accelerated movement)



ChatGPT


Certainly! Here's a fill-in-the-blank activity designed for 12-year-old students to reinforce their understanding of Newton's First and Second Laws of Motion, as well as the relevant units.

Newton's Laws of Motion Activity


Fill in the blanks with the correct words or numbers to complete the sentences about Newton's Laws of Motion.

1. Newton's **First Law of Motion** is also known as the Law of _____. This law states that an object will stay at **rest** or in **uniform movement** if no _____ force acts on it.
2. The First Law implies that if you see an object moving in a straight line with the same speed, it is experiencing **zero** or **balanced** _____.
3. Newton's **Second Law of Motion** can be summarized by the equation $F = m \times a$, where **F** stands for _____, **m** for **mass**, and **a** for _____.
4. In the Second Law, the unit of force is **Newton (N)**, which can be broken down into _____ **x meters/second²**.
5. When a force is applied to an object, the _____ of the object directly affects how much it will accelerate. This means heavier objects need a **larger** force to accelerate at the same rate as **lighter** objects.
6. The unit of mass is the _____, and acceleration is measured in **meters/second²** or **m/s²**.
7. For example, if a car (mass = 1000 kg) accelerates at 2 m/s², the force applied to the car is _____ **Newtons (N)**.
8. Newton's Laws help us understand everyday phenomena, like why a ball thrown in the air comes down, and why it's harder to push a **full** shopping cart than an **empty** one.

Example 1: Lesson Planing and implementation

 **You**

Could you provide a set of excercises about polynomials. Students should find the zeros and extema. All zeros are natural numbers as well as the extrem values

 **math**

 **Let's begin**

Gauth will provide a set of exercises involving polynomials where students are required to find the zeros and extrema. The special feature of these exercises is that all zeros and extrema values are natural numbers.

Exercise Set: Polynomials

1. **Polynomial 1:** $f(x) = x^3 - 6x^2 + 11x - 6$
 - Find the zeros of $f(x)$.
 - Determine the local extrema of $f(x)$.
2. **Polynomial 2:** $g(x) = 2x^4 - 8x^3 + 8x^2$
 - Find the zeros of $g(x)$.
 - Determine the local extrema of $g(x)$.
3. **Polynomial 3:** $h(x) = x^4 - 10x^2 + 9$
 - Find the zeros of $h(x)$.
 - Determine the local extrema of $h(x)$.
4. **Polynomial 4:** $p(x) = 3x^3 - 15x^2 + 18x$
 - Find the zeros of $p(x)$.
 - Determine the local extrema of $p(x)$.
5. **Polynomial 5:** $q(x) = x^3 - 3x^2 - 4x + 12$
 - Find the zeros of $q(x)$.
 - Determine the local extrema of $q(x)$.

Example 2: Lesson Planing and implementation

3. **Polynomial 3:** $h(x) = x^4 - 10x^2 + 9$

• **Find the zeros:**

Factorize: $h(x) = (x^2 - 1)(x^2 - 9)$

Zeros: $x = -3, -1, 1, 3$

• **Determine the local extrema:**

First derivative: $h'(x) = 4x^3 - 20x$

Set $h'(x) = 0$ and solve: Zeros at $x = 0, \pm\sqrt{5}$

Second derivative test for each critical point.

4. **Polynomial 4:** $p(x) = 3x^3 - 15x^2 + 18x$

• **Find the zeros:**

Factorize: $p(x) = 3x(x - 2)(x - 3)$

Zeros: $x = 0, 2, 3$

• **Determine the local extrema:**

First derivative: $p'(x) = 9x^2 - 30x + 18$

Set $p'(x) = 0$ and solve: Zeros at $x = 1, 2$

Second derivative test for each critical point.

5. **Polynomial 5:** $q(x) = x^3 - 3x^2 - 4x + 12$

• **Find the zeros:**

Factorize: $q(x) = (x - 3)(x + 2)(x - 2)$

Zeros: $x = -2, 2, 3$

• **Determine the local extrema:**

First derivative: $q'(x) = 3x^2 - 6x - 4$

Set $q'(x) = 0$ and solve: Zeros at $x = -\frac{1}{3}$ and $x = 4$

Second derivative test for each critical point.

Task 2:

You will work in groups:

Task: Use GPT to generate educational content on a chosen STEM topic.

For example: Plan a lesson that introduces electromagnetic induction with hands on experiments grade in grade 8

Discussion Points:

- Compare the GPT outputs.
- Discuss accuracy and integration into teaching.

Example 1: Lesson Planing and implementation

Summary

1. **Content Generation:** Exercises, slides, worksheets (with solutions), tests
2. **Content adaption:** Content checking, proofreading, language adaption

And more sophisticated:

- Digital Learning content: (Learning websites, digital escape games...) -

Example 1: Lesson Planing and implementation

Summary: BUT Be Careful

- 1.AI has it's difficulties with (mathematical) modeling tasks
- 2.If you research a new topic, make sure that GPT provides references (it tended to hallucinate facts)

However: Math, Science and research abilities have significantly improved

Example 2: Administration



Example 2: Administration

OL

You

I have to write a report on the development of the student Oliver Straser (age 17). The point is, he is lazy, never pays attention, shows no interest in STEM subjects, he is the opposite of a critical thinker, always comes to late and he barely passes all exams. However, I cannot write this in that way. Could you write a report that sounds professional and the the reader will understand all these aspects but they are not written explicitly



ChatGPT

Absolutely, crafting a professional and tactful report that conveys the necessary information about Oliver Straser in a respectful manner is important. Here's a suggested approach for the report:

Student Development Report: Oliver Straser

Age: 17

Date: [Insert Date]

Educator: [Your Name]

1. Engagement in Academic Activities:

Oliver displays a unique approach to academic engagement, particularly in STEM subjects. His interaction with these topics often diverges from traditional enthusiasm, suggesting a potential for alternative learning methods to better align with his personal academic style. Encouraging Oliver to explore diverse educational strategies could be beneficial in fostering a more robust connection with these subjects.

2. Classroom Participation and Attention:

In classroom settings, Oliver's participation is often understated, indicating a preference for observation over active involvement. Enhancing his engagement could be achieved through tailored pedagogical approaches that resonate more closely with his individual learning preferences. This might include more hands-on or interactive learning experiences to capture his interest more effectively.

3. Critical Thinking Skills:

Oliver's approach to critical thinking and problem-solving exhibits a non-conventional pattern. He tends to reserve judgment and may benefit from structured guidance to develop more analytical perspectives. Incorporating exercises that promote critical thinking and reasoning in a step-by-step manner could be advantageous in nurturing these skills.

4. Punctuality and Time Management:

Oliver's relationship with time management and punctuality presents opportunities for growth. Developing strategies to enhance his time-keeping skills would not only benefit his academic progress but also prepare him for future professional environments. Introducing personal organization tools and time management workshops could be a constructive step forward.

5. Academic Performance and Assessment:

Oliver's academic performance, particularly in examinations, hovers around the threshold of proficiency. This suggests that while he grasps fundamental concepts, there is room for deeper understanding and mastery. Personalized support, such as tutoring or additional study sessions, could be instrumental in helping him achieve a more comprehensive grasp of the material.

Conclusion and Recommendations:

Oliver Straser is a student with distinctive learning approaches and potentials. While his current academic strategies pose challenges, they also offer opportunities for tailored educational interventions that could significantly enhance his learning experience. Recommendations include exploring alternative teaching methods, structured support for critical thinking development, time management training, and personalized academic support. With the right guidance and resources, Oliver has the potential to develop a more profound and engaged relationship with his educational journey.

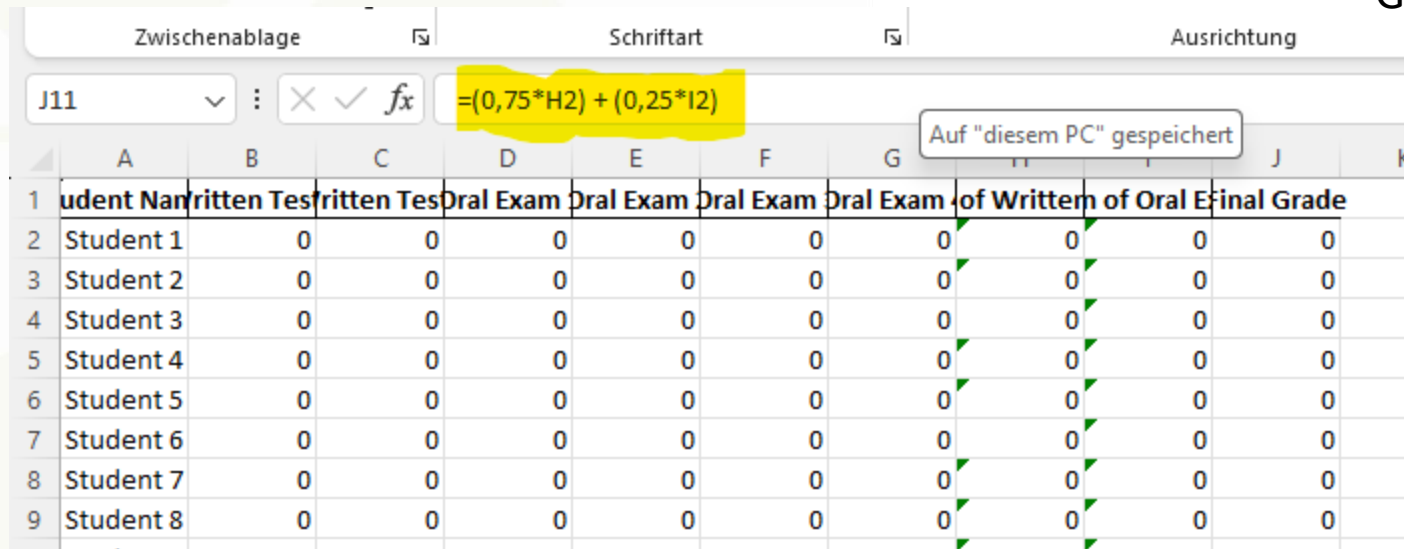
Example 2: Administration

OL **You**

I need an excel sheet to calculate grades: Each student has two written tests and 4 oral examinations. Please also calculate the mean of the written and the mean of the oral examinations. The final grade is composed of 75% of the written exams and 25% of the oral exams -> could you provide me such a file for 30 students?

Example 2: Administration

GPT 4



The screenshot shows a spreadsheet interface with a formula bar containing the formula $= (0,75 * H2) + (0,25 * I2)$. Below the formula bar is a table with 11 columns (A-K) and 10 rows (1-9). The table headers are: Student Name, Written Test, Written Test, Oral Exam, Oral Exam, Oral Exam, Oral Exam, of Written, of Oral, and Final Grade. The data rows show scores for Student 1 through Student 8, with all scores being 0. A tooltip 'Auf "diesem PC" gespeichert' is visible over the table.

	A	B	C	D	E	F	G	H	I	J	K
1	Student Name	Written Test	Written Test	Oral Exam	Oral Exam	Oral Exam	Oral Exam	of Written	of Oral	Final Grade	
2	Student 1	0	0	0	0	0	0	0	0	0	0
3	Student 2	0	0	0	0	0	0	0	0	0	0
4	Student 3	0	0	0	0	0	0	0	0	0	0
5	Student 4	0	0	0	0	0	0	0	0	0	0
6	Student 5	0	0	0	0	0	0	0	0	0	0
7	Student 6	0	0	0	0	0	0	0	0	0	0
8	Student 7	0	0	0	0	0	0	0	0	0	0
9	Student 8	0	0	0	0	0	0	0	0	0	0

Example 2: Administration

Summary: GPT can help teachers with the following

- Writing from sketches (emails, reports ...)
- Productivity: Produce Excel Sheets, Form Letters, Lesson Plans...
- Monitoring student development

Example 3: Assessment, Diagnostics and Evaluation



Example 3: Assessment, Diagnostics and Evaluation


- Basic example: How teachers can use AI?

Student's solution:


$$\frac{4}{3} + \frac{2}{5} = \frac{6}{8}, \quad \frac{1}{2} + \frac{1}{3} = \frac{2}{5}, \quad \frac{8}{3} - \frac{3}{2} = \frac{5}{1}$$

What happened?

Example 3: Assessment, Diagnostics and Evaluation

 **You**

One of my students keeps struggling in math: Here are his solutions: What do you think is the problem: $4/3+2/5=6/8$, $1/2+1/3=2/5$, $8/3-3/2=5/1$

 **ChatGPT**

It appears that your student is having difficulty with adding and subtracting fractions. The problems provided have incorrect solutions. Here's a breakdown of each problem:

1. $4/3 + 2/5 = 6/8$

The student's solution is incorrect. The correct solution is:

$$4/3 + 2/5 = (20/15) + (6/15) = 26/15$$

2. $1/2 + 1/3 = 2/5$

The student's solution is incorrect. The correct solution is:

$$1/2 + 1/3 = (3/6) + (2/6) = 5/6$$

3. $8/3 - 3/2 = 5/1$

The student's solution is incorrect. The correct solution is:

$$8/3 - 3/2 = (16/6) - (9/6) = 7/6$$

It seems that the student is struggling with the concepts of finding common denominators and performing arithmetic operations with fractions. They may need additional practice and instruction on these topics to improve their math skills. It's important to provide them with more practice problems and step-by-step guidance on how to properly add and subtract fractions.

Example 3: Assessment, Diagnostics and Evaluation

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Ok that didn't help that much

Example 3: Assessment, Diagnostics and Evaluation

You
do you think he has any misconception?

- ChatGPT**
Yes, it's possible that the student has misconceptions about fractions, which are leading to the incorrect solutions. Some common misconceptions related to fractions include:
1. Treating the numerators and denominators separately: In the first two problems, it seems the student may be adding or subtracting the numerators without considering the denominators. They should understand that you can only add or subtract fractions with the same denominators.
 2. Misunderstanding the concept of common denominators: It appears that the student might not be finding a common denominator before performing operations on fractions. It's crucial to recognize that when adding or subtracting fractions, you need a common denominator.
 3. Not simplifying fractions: In some cases, the student's solutions are not simplified to their lowest terms. For example, in the third problem, $5/1$ should be simplified to just 5. It's essential to teach them to simplify fractions whenever possible.

To help the student overcome these misconceptions, it's crucial to provide clear explanations and practice problems that focus on these specific concepts. Encourage them to understand the underlying principles of fractions and emphasize the importance of finding common denominators when adding or subtracting them. Additionally, providing visual aids or manipulatives can be helpful in making these concepts more concrete for the student.

Example 3: Assessment, Diagnostics and Evaluation



You

what would you recommend to resolve this misconceptions



ChatGPT

To help your student overcome these misconceptions related to fractions, here are some recommendations:

1. Review the Basics:

Start by reviewing the fundamental concepts of fractions with your student. Ensure they have a solid understanding of what a fraction represents, including the numerator (top number) as the part and the denominator (bottom number) as the whole.

2. Common Denominators:

Teach your student the importance of finding a common denominator when adding or subtracting fractions. Explain that fractions with different denominators need to be converted to have the same denominator before performing operations.

3. Visual Aids:

Use visual aids like fraction bars or circles to illustrate fractions and their operations. This can help make the concepts more tangible and easier to grasp.

Example 3: Assessment, Diagnostics and Evaluation



You

could you provide tasks to do so?



ChatGPT

Certainly! Here are some tasks and practice problems that can help your student improve their understanding of fractions, specifically focusing on adding and subtracting fractions with like and unlike denominators:

Adding Fractions with Like Denominators:

1. Task: Add the following fractions with like denominators:
 - a. $\frac{1}{4} + \frac{3}{4}$
 - b. $\frac{2}{5} + \frac{1}{5}$
 - c. $\frac{5}{8} + \frac{7}{8}$
2. Task: Create word problems or scenarios that involve adding fractions with like denominators. For example, "You have $\frac{1}{3}$ of a pizza, and your friend gives you $\frac{2}{3}$ of another pizza. How much pizza do you have in total?"

Adding Fractions with Unlike Denominators:

Example 3: Assessment, Diagnostics and Evaluation

First conclusion:

- GPT can help analyze student solutions
- GPT can help identifying common misconceptions
- GPT can produce tasks that help to overcome these misconceptions

Therefore

- GPT can be used for automated assessment (in certain areas)
- But...

Example 3: Assessment, Diagnostics and Evaluation

Now with GPT4

 You

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 ChatGPT

It seems that your student is struggling with the fundamental concepts of adding, subtracting, and manipulating fractions. The errors in their solutions suggest a misunderstanding in several key areas:

1. **Finding a Common Denominator:** When adding or subtracting fractions, it's essential to find a common denominator. Your student doesn't seem to be doing this correctly. For example, in the first problem ($4/3 + 2/5$), the student needs to find a common denominator for 3 and 5, which would be 15, not 8 as they used.
2. **Simplifying Fractions:** After finding the sum or difference of fractions, it's important to simplify the fraction if possible. This step seems to be missing or incorrectly done in your student's work.
3. **Incorrect Basic Arithmetic:** The answers provided show incorrect basic arithmetic. For instance, in the last problem ($8/3 - 3/2$), the student's answer is $5/1$, which is incorrect both in terms of the procedure for subtracting fractions and the arithmetic involved.

To help your student, I recommend revisiting the basics of fractions:

- How to find a common denominator.
- How to add and subtract fractions using common denominators.
- The importance of simplifying fractions.
- Practicing basic arithmetic operations with fractions.

Using visual aids, such as fraction bars or pies, can also be helpful in giving a more intuitive understanding of how fractions work.



Example 3: Assessment, Diagnostics and Evaluation

Now we change the setting and use GPT Pro as follows (Joint work with Andreas Kothe)

- Addition, subtraction of decimal numbers and fractions.
- Instead of typed solution we take handwritten notes
- We create our own GPT by giving clear advise (check solutions for misconceptions, use literature xyz, give advice)

Result:

If the handwritten notes were interpreted correctly, then

- The assessment accuracy is 100% correct
- The detection of misconceptions is 90% correct

Example 3: Assessment, Diagnostics and Evaluation

So, AI has the possibility of

- Correcting student solutions
 - Diagnose misconceptions and provide individual learning strategies
 - Reflecting on your teaching: What works and what doesn't
- > AI could also work as personalized tutor

But...

- Data protection issues need to be resolved
- Quality of an “AI-tutor” must be checked

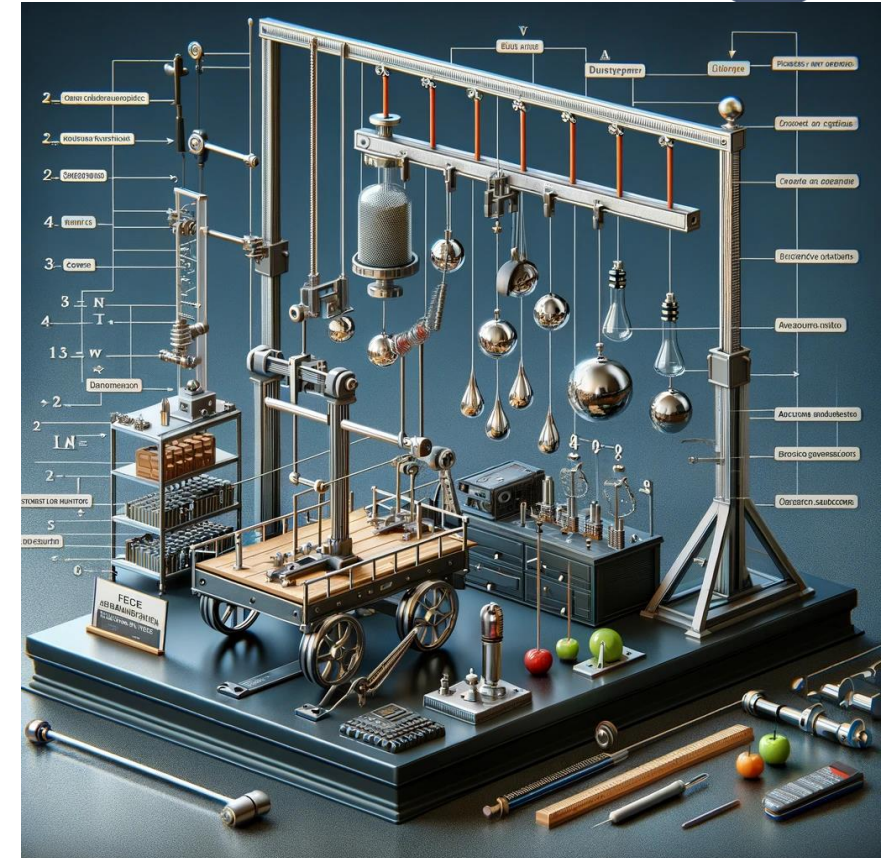


Summary

GPT has its limitations and requires several digital competencies!

You need to know:

- How to communicate effectively?
- What are the limitations?
- What are the biases?





Summary: Use of AI as a digital competency

Knowledge:

- Basic Understanding of AI:
- Ethical and Legal Aspects of AI:
- AI and Data Literacy:

Skills:

- AI Tool Proficiency
- Critical Thinking and Problem-Solving: .
- Programming and Technical Skills

Attitudes:

- Openness to Innovation
- Ethical and Responsible Use
- Continuous Learning
- Critical Reflection



Generell discussion:

What do you think, will AI have an important role in STEM-Education?

1. What chances do you see?
2. What must improve?
3. Are there any ethical concerns?

Thank you

Feel free to email direct feedback or any wishes to: oliver.straser@ph-freiburg.de



AI Tools

Chatbots

- ChatGPT (Open AI)
- Bard (Google)
- Grog (X formely know as Twitter)
- Perplexity

Image Generation

- Midjourney
- Leonardo AI
- Dall-E (OpenAI)

AI for STEM Education: <https://ditchthattextbook.com/ai-tools/>



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- Teaching Materials: <https://www.teach4life.eu/>
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Cheet Sheet

Act as a Role	Create a [TASK]
1. Analyst	1. Headline
2. Teacher	2. (Scientific) Article
3. Marketer	3. Essay
4. Developer	4. Book Outline
5. Meditation Instructor	5. Report
6. Mindset Coach	6. Introduction
7. Therapist	7. Email Sequence
8. Journalist	8. Social Media Post for...
9. Inventor	9. Summary (include text or file)
10. Lawyer	10. Product Description
11. Scientist (subject?)	11. Cover Letter
12. Website Designer	12. Blog Post
13. Best Selling Author	13. SEO Keywords
14. Expert Copywriter	14. Summary
15. Account Engineer	15. Video Script
16. Project Manager	16. Recipe
17. Financial Analyst	17. Sales Copy
18. Full Stack Developer	18. Analysis
19. "Position" Interviewer	19. Web Page



Cheet Sheet

Show as FORMAT	Set restrictions	Tones	Writing Styles
1. Table	1. Use scientific language	11. Friendly	<ul style="list-style-type: none"> • Technical • Humorous • Academic • Poetic • Journalistic • Conversational • Descriptive • Persuasive • Satirical • Comparative
2. A List	2. Use academic language	12. Motivational	
3. Summary	3. Use poetic language	13. Inspirational	
4. HTML	4. Adopt a formal tone	14. Authoritative	
5. Code	5. Write short sentences	15. Educational	
6. Spreadsheet	6. Code only in HTML/CSS	16. Thoughtful	
7. Graphs	7. Use Shakespearean style	17. Encouraging	
8. CSV file	8. Write using basic English	18. Serious	
9. Plain Text file	9. Use only scientific sources	19. Informal	
10. JSON	10. Add pop culture references		
11. Rich Text			
12. PDF			
13. XML			
14. Markdown			
15. Gantt Chart			
16. Word Cloud			
17. Emoji			
18. An Analysis			
19. Bullet Points			