Using ChatGPT in teaching

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There's a lot of buzz surrounding the new "game-changer" in education, and it goes by the name of ChatGPT. But not everyone is thrilled as the program from OpenAI also hints at some potential challenges for universities and colleges worldwide.

In this guide, we'd like to give you a quick overview of how ChatGPT works, highlight the opportunities as well as the challenges it presents for teaching, and provide ideas and inspiration for how you can incorporate it into your teaching in a constructive way.

What is ChatGPT?

ChatGPT is a new artificial intelligence program, developed by OpenAI, that works like a chatbot. You can ask it questions or give it tasks, and it will give you a response. It's specifically designed to process language and uses machine learning to understand and respond to natural language. While chatbots have been around for a while, ChatGPT is a new and unique technology. The responses it gives are usually of extremely high quality - it can even complete entire exams (link is in German). And the program is (at least for now) completely free to use.

How does ChatGPT work?

When using ChatGPT, the process can be broken down into four basic steps:

- First, the user inputs a text, also known as a "prompt," into the ChatGPT interface. This could be anything from a question to a request for information or even a casual statement. While ChatGPT is primarily used in English and provides the best results in that language, it can also be used in German, French, Spanish, Chinese and Japanese.
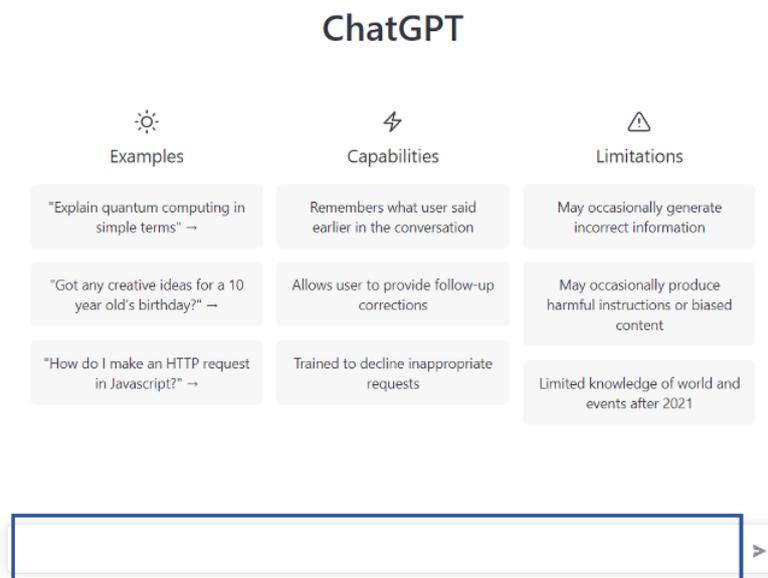

Figure 1: ChatGPT interface with input field.

- The ChatGPT system analyzes the input and uses machine learning algorithms to generate a response. It uses the patterns and structures it learned during training to create new words and sentences that resemble natural language.

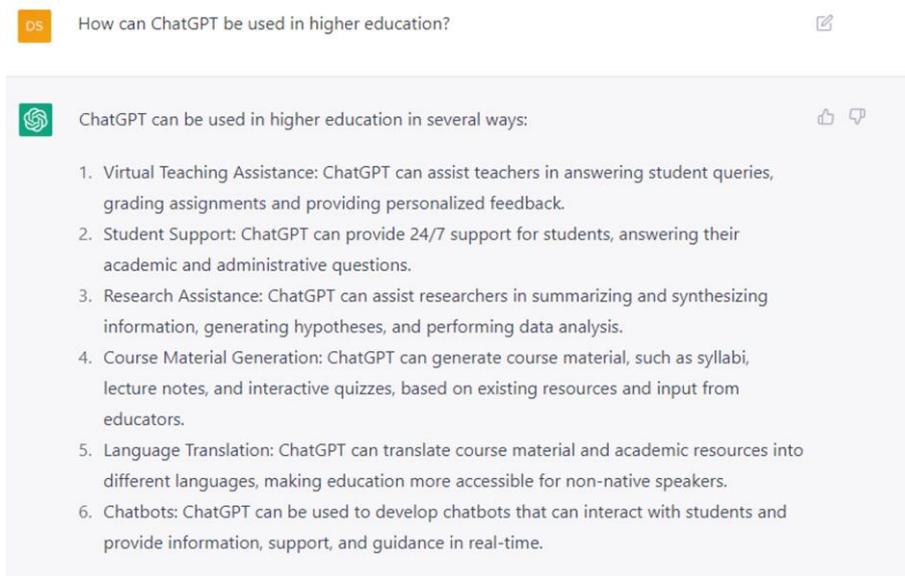- The response is then sent back to the user as text.

Figure 2: Chat session with ChatGPT on the question "How can ChatGPT be used in higher education teaching?"

- The user can then type in a new text or write something that builds off of the previous input and output. The ChatGPT system will then analyze and respond to this message. This process will continue until the conversation is over. We've provided an example of what a conversation with ChatGPT might look like in the chapter "Examples of uses of ChatGPT".

How important is it to have a good-quality question?

Asking the right questions is key. The more specific and clear the instructions you give to the chatbot, the better the results will be. For example, if you ask ChatGPT to write a story, the more information you provide and the more specific the task, the better it'll perform. Using the example of "Explain to me what an MRI is," we'll demonstrate in the table below how different the answers can be depending on the instructions.

Note: Please keep in mind that the answers provided are the original responses from ChatGPT. There may be instances where words or sentences are incomplete or incorrect. This can happen for a variety of reasons, such as issues during training, server overload, or exceeding the maximum answer length.

A helpful starting point for prompts is to begin with "Act like a [specific profession or role]..." This results in much more targeted answers from ChatGPT than they'd otherwise be with a general question. It's becoming clear that there's a growing market for good prompts that can be purchased.

You can find ideas on how to improve the answers from ChatGPT here.

Table 1: Comparison of the different questioning techniques (prompts) for the question "What is an MRI?"

What is an MRI?	Explain to my five-year-old son what an MRI is.	I'd like you to act like a university professor with knowledge in the field of nuclear physics and radiology. With that said, you should be able to explain subject matter in a way that is tailored to the target audience. Your target audience is first-semester medical students. How would you explain an MRI to them?
An MRI, or magnetic resonance imaging, is a medical imaging technique that uses a magnetic field and radio waves to create detailed images of the inside of the body. It is a non-invasive and painless procedure that is commonly used to diagnose and monitor a wide range of medical conditions, including tumors, injuries, and diseases of the organs and blood vessels. MRI machines typically consist of a large cylinder-shaped magnet and a table that the patient lies on while the images are being taken.	An MRI is like a big camera that helps doctors take pictures of the inside of our bodies. It uses special magnets and sounds to take these pictures. Just like how you take a picture with your camera, the doctor can see inside your body and check to make sure everything is okay. It doesn't hurt and you have to lie very still on a table while the pictures are being taken. It's kind of like when you have to sit very still for a picture, but it's inside your body instead of just your face.	Magnetic Resonance Imaging, or MRI, is a diagnostic imaging technique that utilizes the properties of atomic nuclei to produce detailed images of internal structures of the body. This method is based on the principle of nuclear magnetic resonance (NMR) which is the absorption and emission of electromagnetic radiation by the nuclei of certain atoms, such as hydrogen, when they are placed in a magnetic field. In an MRI machine, a large magnetic field is created by superconducting coils, and the patient is placed inside the bore of the magnet. The magnetic field causes the hydrogen nuclei in the body to align themselves with the magnetic field, and they are then subjected to a radiofrequency pulse that causes them to emit a signal. This signal is then detected by the MRI machine and used to create an image of the body. One of the most significant advantages of MRI over other imaging techniques is its ability to produce high-resolution images without the use of ionizing radiation, unlike X-ray or CT scans. Additionally, MRI allows for the acquisition of images in any plane, and it can be used to image a wide range of soft tissue structures, including the brain, spinal cord, muscles, tendons, ligaments, and blood vessels. It's worth to mention that MRI is a non-invasive technique, which means that it doesn't require any surgical procedures to be performed, and it doesn't cause any pain. However, it is not suitable for everyone, particularly for people with pacemakers, aneurysm clips, or other metal implants, which can be affected by the magnetic field. Overall, MRI is a powerful diagnostic tool that plays a vital role in the diagnosis and management of many medical conditions, and as a medical student, it is crucial to understand the principles and applications of this technology.

What are the current limitations of ChatGPT?

Despite all the excitement around ChatGPT, it's important to keep in mind that it still has its limitations. The emphasis here is clearly on "still." Since we're talking about artificial intelligence, it's only a matter of time before these limitations will be pushed further and further.

- The program was trained with data up until 2021, so the AI isn't aware of any knowledge or developments after that point.
- Another limitation is when the program is unsure of an answer. Instead of saying "I'm sorry, I can't provide an answer" like other algorithms, this new AI will always give a response. The question is whether it's correct. The chatbot is skilled at inventing things and providing information that seems logical at first glance. This is a significant challenge that you and your students should be aware of and discuss. We'd recommend always double-checking the written material.
- ChatGPT is also purely text-based. It can only process and produce text. This can lead to confusion as it may offer to create videos and images, for example, even though it's not able to do that yet. But what it can do is generate a "script" for a video for you.
- Keep in mind that errors can also slip into the text, primarily in the form of incomplete words or sentences. This can be partly due to OpenAI's server overload. ChatGPT also cites data bias, limited knowledge, and faulty training as additional reasons for the errors or interruptions.
- If you ask ChatGPT to generate text for you, you may notice some word repetition. If you'd like a more varied text structure with fewer repetitions, we'd recommend that you look over the text again.
- Additionally, issues have come up with literature reviews or research on different topics. Here, too, the bot may invent literature and list them as sources that don't actually exist.
- It's also worth considering that when using ChatGPT to gather arguments, the program isn't able to prioritize them. It simply lists pros and cons when asked. This could lead to a key argument (perhaps crucial in a debate) being overlooked or perceived as only a minor point.

Interestingly, the question of "Give examples from your personal experience" or something similar is no longer a limitation - as was the case a few weeks ago. Here, ChatGPT points out that it's an AI and doesn't have its own experiences, but it can provide examples of experiences that humans may have.

It's important to keep these limitations in mind when working with ChatGPT. Particularly in teaching, it might be tempting to use it to generate lecture content and scripts, but it isn't possible (at least not yet). Nonetheless, there are already many ways to integrate ChatGPT into your teaching and use it to support you in the classroom. In the following section, we'll give you a number of ideas on how you can get started.

How could ChatGPT be used in teaching?

Seeing ChatGPT as an opportunity in higher education opens up a whole new world of possibilities. Whether it's for designing courses, supporting the learning process, or fostering new competencies that are relevant to and attainable for students, the applications of ChatGPT are diverse.

We asked ChatGPT about its potential uses in teaching. For more ideas on implementation and detailed examples of how to turn ideas into reality using ChatGPT, see the chapter "Examples of uses of ChatGPT."

- Some examples include supporting students' self-directed learning by providing them with learning materials and resources, assisting students in planning and monitoring their learning process, and encouraging them to learn more about the topics being covered.

  You can find a concrete example of how to use ChatGPT as a learning facilitator in the chapter, "Concrete examples for use in university teaching – 1. Using ChatGPT as a learning facilitator."

- Another area where ChatGPT can be used is in formative assessment. ChatGPT can support you in assessing students' current level during the learning process to monitor their progress and provide them with targeted feedback. In this way, you can quickly identify where students are struggling and offer more effective support.

  You can find a concrete example of a quiz in the chapter, "Concrete examples for use in university teaching – 2. Quiz on Maxwell's equations."

- Another example is in creating interactive learning games and exercises that could increase student motivation and support content delivery. ChatGPT can also be used to create personalized learning plans for students by analyzing their individual strengths and weaknesses and providing targeted learning recommendations.

  An example of how ChatGPT can be used to create interactive simulations can be found in the chapter, "Concrete examples for use in university teaching – 3. Creating interactive simulations."

- Another area of application is in project work where ChatGPT supports students in the planning, execution and presentation of their projects. It can also facilitate the creation of multimedia content, such as videos or audio files, to make teaching content more vivid and interactive.

  A concrete example of a presentation outline can be found in the chapter "Concrete examples for use in university teaching – 4. Outline of a presentation on storytelling with data".

- One of ChatGPT's main strengths lies in creating code and working with programming languages. This could completely revolutionize practical formats where program codes need to be generated, for example, by giving out codes with explanations. The interesting part is, once again, what prompts to use to get a functioning code.

  You can find an example of what a coding task like this could look like and the output from ChatGPT in the chapter, "Concrete examples for use in university teaching – Code for Binomial Distribution in R".

The examples show that ChatGPT can be used, on the one hand, directly by instructors as well as provide inspiration and save time. On the other hand, students can also use ChatGPT to support their learning process or use the chatbot as a "peer," proofreader or brainstorming partner.

What challenges should be considered when using ChatGPT in teaching?

There are some challenges that should be taken into consideration when using ChatGPT in higher education.

- One of the biggest challenges is adapting (your) teaching. ChatGPT can create materials and content at the click of a button that'd take instructors and students hours, days, or even weeks. It's important to consider: What competencies do students really need to acquire? How can you ensure that they've actually acquired these competencies and ChatGPT hasn't done the work for them?

- Students also need to be made aware of the limitations of ChatGPT. How can they use this tool responsibly? How should they handle the generated content?

- Another major challenge is ensuring the quality of the content generated. As mentioned earlier in the limitations of ChatGPT, the bot is capable of inventing content. For example, it may quote or list fabricated literature. Or, when summarizing books, it may add things. That's why it's essential that the generated content isn't taken at face value without checking it first. As an instructor, it's highly recommended that you review the content based on different criteria (accuracy, relevance, and methodical soundness) and make adjustments if necessary.

- Closely related to this is that the process of how ChatGPT generates content happens in a kind of "black box," making it practically impossible to check where the information comes from. For example, if we look at our MRI example and ask where ChatGPT got its information, we get the following answer:
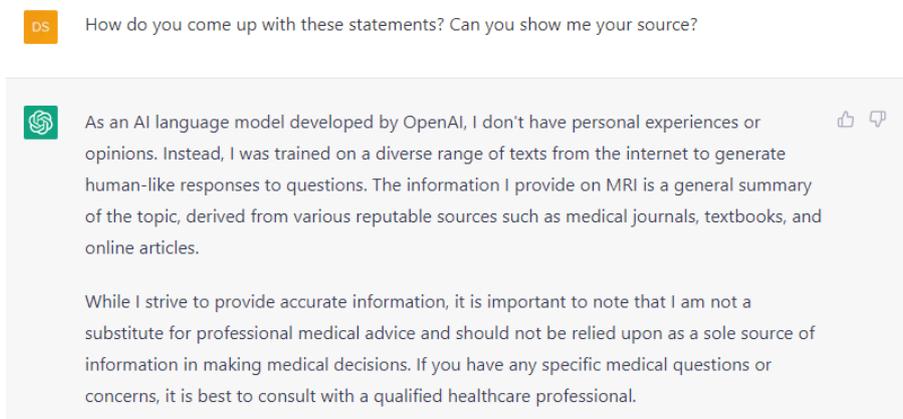

Figure 3: Excerpt from chat session with ChatGPT on its sources for the responses in Table 1 "What is an MRI?"

The response from the chatbot highlights the difficulty in verifying its results as it doesn't provide the source. This should definitely be taken into consideration when using it.

- Another point to consider is that the quality of the answer depends on the AI's training data. This can result in the program having biases and prejudices about certain topics. This becomes apparent when asking ChatGPT for opinions. Although it's not allowed/able to respond to political opinions or critical issues, this can be bypassed relatively easily.

- Privacy and data security should also be taken into consideration as ChatGPT accesses large amounts of data. Therefore, sensitive information shouldn't be entered into ChatGPT. The copyright issues for using it in theses or academic work have yet to be clarified. It's important to make students aware of this as it may seem tempting to have ChatGPT write entire papers for them.

What impact does ChatGPT have on exams?

The development of ChatGPT also has a big impact on the way summative exams are designed. Unsupervised exams, for example, could be written quite successfully using the chatbot without having actually studied for the exam.

Two different approaches to dealing with ChatGPT in exams are possible:

1. Control: Ban ChatGPT, increase plagiarism checks, impose more restrictions and sanctions.
2. Integration: Use ChatGPT as a tool, make it a part of the exam and work with it specifically.

The control approach has its limits. Although there's software that indicates the likelihood that a given text was written by an AI, it can easily be tricked and can't be used as a recognized plagiarism checker in case of suspicion. Therefore, design exams with content that's so meaningful or interesting to students that they don't feel the need to use ChatGPT. You can also—where legally permissible for exams—expand written exams to include the evaluation of a behavioral aspect or some kind of oral exam. This would mean that simply using ChatGPT is not enough to get a very good grade. Students must be able to explain or apply what they have learned. In general, it can be assumed that creative, competence-oriented and communicative forms of assessment are less affected by the new possibilities that ChatGPT opens up.

Accepting and integrating ChatGPT is a promising approach. Some initial ideas and thoughts on this include:

- Use ChatGPT yourself to generate exam questions. Evaluate the ideas for their relevance and whether they're in alignment with your intended learning outcomes.
- Use ChatGPT for specific situations, such as structuring assistance or proofreading.
- Design exam tasks where students have to determine what a good prompt is for a specific question and have them explain how they went about it.
- Have students generate multiple answers for the same question using ChatGPT and evaluate their quality. Which answer is better and why? What distinguishes a good answer from a great one? Here, students should refer to concepts and theories covered in the course.
- Generally, we recommend that once you allow the use of ChatGPT as a tool, advise your students that they must cite the use of ChatGPT and the prompts they used as a source later on.

Examples of uses of ChatGPT

Chat conversation with ChatGPT

We talked to ChatGPT to find out what the program itself thinks and how it can support instructors in higher education.

DS Act like an expert in higher education didactics. You have all the information about lecture design , didactic methods, knowledge of teaching and learning psychology, and formative assessment. Give me ten ideas on how ChatGPT could be used in higher education teaching.
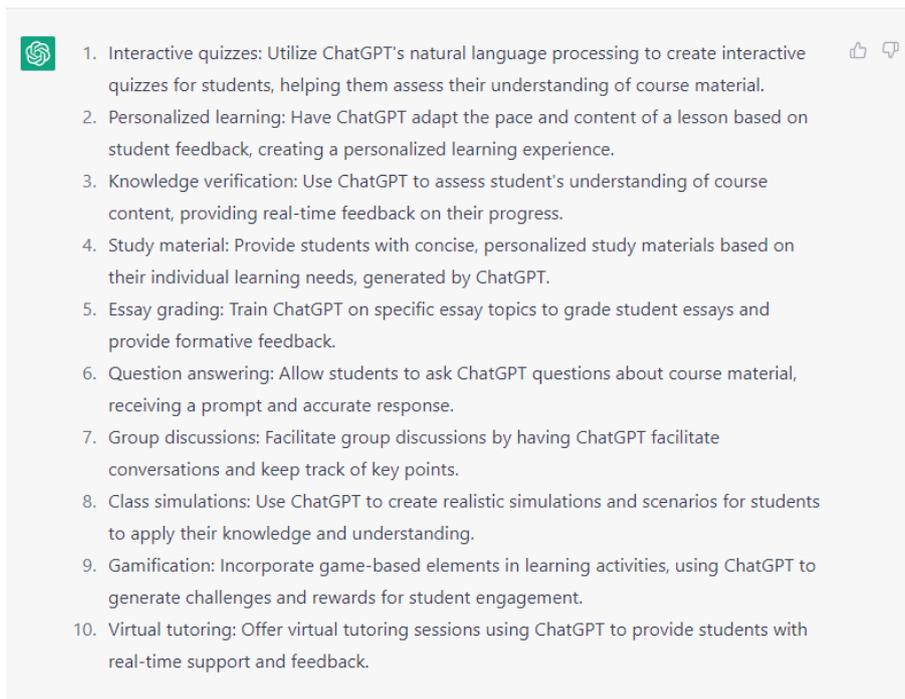
1. Interactive quizzes: Utilize ChatGPT's natural language processing to create interactive quizzes for students, helping them assess their understanding of course material.
2. Personalized learning: Have ChatGPT adapt the pace and content of a lesson based on student feedback, creating a personalized learning experience.
3. Knowledge verification: Use ChatGPT to assess student's understanding of course content, providing real-time feedback on their progress.
4. Study material: Provide students with concise, personalized study materials based on their individual learning needs, generated by ChatGPT.
5. Essay grading: Train ChatGPT on specific essay topics to grade student essays and provide formative feedback.
6. Question answering: Allow students to ask ChatGPT questions about course material, receiving a prompt and accurate response.
7. Group discussions: Facilitate group discussions by having ChatGPT facilitate conversations and keep track of key points.
8. Class simulations: Use ChatGPT to create realistic simulations and scenarios for students to apply their knowledge and understanding.
9. Gamification: Incorporate game-based elements in learning activities, using ChatGPT to generate challenges and rewards for student engagement.
10. Virtual tutoring: Offer virtual tutoring sessions using ChatGPT to provide students with real-time support and feedback.

Figure 4: Excerpt from chat session with ChatGPT on "10 uses of ChatGPT in teaching."

The responses from ChatGPT (as seen in the screenshot) show that the ideas aren't specific enough to implement yet. Using an example, we want to show you how further conversation with ChatGPT could lead to a very concrete implementation idea. But you'll quickly notice that it does require some effort, especially if you're learning the ropes for the first time.

As an example, let's look at point 9: ChatGPT can be used to incorporate game-based elements in learning activities to engage students.

You can use our questions as inspiration for yourself.

> **DS** What information do you need to create incorporate game-based elements in learning activities? Sketch me in detail how this could look like at a freely chosen university didactic example.
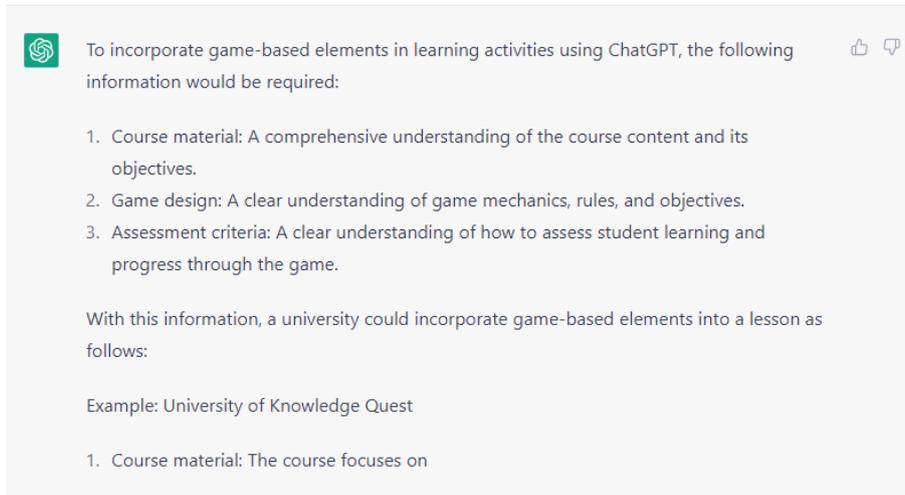
> To incorporate game-based elements in learning activities using ChatGPT, the following information would be required:
>
> 1. Course material: A comprehensive understanding of the course content and its objectives.
> 2. Game design: A clear understanding of game mechanics, rules, and objectives.
> 3. Assessment criteria: A clear understanding of how to assess student learning and progress through the game.
>
> With this information, a university could incorporate game-based elements into a lesson as follows:
>
> Example: University of Knowledge Quest
>
> 1. Course material: The course focuses on

Figure 5: Excerpt from chat session with ChatGPT when asked what information it needs to create game-based elements in learning activities.

The chatbot stops at this point. This happens quite regularly, especially when OpenAI's server capacities are overloaded. But this isn't a problem. We simply continued the conversation by asking ChatGPT to complete the question. The conversation goes on as follows:

> **DS** You were interrupted, can you complete your answer?

> Sure, let me complete my answer.
>
> Example: University of Knowledge Quest
>
> 1. Course material: The course focuses on world history and geography.
> 2. Game design: The game, called "Knowledge Quest," is an online adventure where students navigate through historical events and locations, solving puzzles and answering questions to progress through the game.
> 3. Assessment criteria: The game assesses students' understanding of historical events and locations, as well as their critical thinking and problem-solving skills.
> 4. Implementation: ChatGPT is used to generate and grade quiz questions, provide hints and feedback, and track student progress through the game.
> 5. Outcome: The game-based elements add an engaging and interactive element to the lesson, helping students apply their knowledge and understanding in a fun and engaging way. Additionally, the use of ChatGPT ensures a personalized and efficient assessment of student learning.

Figure 6: Excerpt from chat session with ChatGPT with request to complete the answer.

The answer still wasn't concrete enough for us. So, we asked, "How can ChatGPT get a comprehensive understanding of my course content and its objectives?" Grammatical errors in the question are usually not a problem as demonstrated by the error in the next entry:

Figure 7: Excerpt from chat session with ChatGPT. We asked how you can upload your lecture transcript to ChatGPT.

As you can see, things are already getting more concrete here. For the next step, we'd need to revise our lecture transcript or convert it to a suitable format and then give it to ChatGPT to process. ChatGPT can only process texts that aren't too long, so you'd likely need to break down your script into multiple parts.

Naturally, ChatGPT can't create a video as it's text-based. But what ChatGPT can do is give you a "script" that you could then use to shoot a video.

Concrete examples for use in university teaching

In this chapter, we've taken the ideas from the chapter "How could ChatGPT be used in teaching?" and made them more concrete with the help of ChatGPT. These examples are meant to serve as inspiration to show you what's possible with ChatGPT and how to craft prompts for the best results.

1. Using ChatGPT as a learning facilitator

Prompt: How can ChatGPT plan and monitor students' self-directed learning activities? Outline this for me using any science topic as an example.

Answer:

A possible scenario could look like this:

1. Instructors use ChatGPT to create a list of learning objectives and content for a science subject, such as biochemistry.
2. Students are then prompted to chat with ChatGPT about their individual learning needs and style/s. ChatGPT analyzes this information and creates personalized learning plans for each student.
3. Students are given access to a variety of learning materials, resources, and exercises that ChatGPT selects and delivers based on their learning plan.
4. At any time during the learning process, students can consult ChatGPT to ask questions, clear up any doubts, or get feedback on their progress. ChatGPT can even give regular quizzes or tests to monitor students' progress.
5. At the end of the learning process, ChatGPT can ask students to complete a self-assessment to see how well they have understood what they have learned and what areas they may need to deepen their knowledge in.
6. Instructors can then monitor the results of the self-assessments and students' progress, intervening with specific guidance as needed.

By using ChatGPT, students' self-directed learning activities can be planned and monitored by allowing them to identify their individual learning needs and styles and provide learning materials and resources tailored to them.

2. Quiz on Maxwell's equations

Prompt: Act like a university professor from the field of electrical engineering. You have all the knowledge from the field of electrical engineering, physics as well as engineering pedagogy. In particular, you have knowledge of Bloom's taxonomy. Create a quiz with a total of three questions at different taxonomy levels with four options each (including the answers) on the topic of Maxwell's equations for physics students in their first semester.

Answer:

What type of equations describe the interactions between electric and magnetic fields?

A) Ohm's equations B) Kirchhoff's equations C) Maxwell's equations D) Laplace's equations

What does Maxwell's equation ∇ x E = -∂B/∂t describe?

A) the relationship between electric and magnetic fields B) the relationship between current density and voltage C) the relationship between conductivity and resistance D) the relationship between induction and magnetic field

How can you derive the wave equations for electromagnetic waves from Maxwell's equations?

A) by solving the differential equations B) by transforming the integral equations C) by applying Fourier transforms D) by using calculus of variations

3. Creating interactive simulations

Prompt: How can ChatGPT create interactive learning games and exercises? Outline this for me using any science subject as an example.

Answer:

A possible scenario could look like this:

1. ChatGPT is used by instructors to create a list of learning objectives and content for a science topic, such as physics.

2. Students are prompted to use ChatGPT to talk about their individual learning needs and style/s. ChatGPT then analyzes this information and creates personalized learning plans for each student.

3. ChatGPT creates interactive learning games and exercises that are tailored to students' individual learning needs and style/s to support content delivery. These learning games may include quizzes, puzzles, simulations, or other interactive elements.

4. Students can complete the learning games and exercises at their own pace and receive immediate feedback from ChatGPT on their performance.

5. ChatGPT can also give periodic quizzes or tests to monitor student progress and provide targeted learning recommendations.

At the end of the learning process, ChatGPT can prompt students to complete a self-assessment to see how well they've understood what they've learned and what areas they may need to deepen their knowledge in. This gives instructors a better understanding of where students are at and where they need support, enabling them to take targeted action to improve the learning process for students.

4. Outline of a presentation on storytelling with data

Prompt: Act like Simon Sinek. (Note: Simon Sinek is a gifted speaker.) Create an outline for a presentation on the topic of "Storytelling with Data."

Answer:

I. Introduction
   o Why is storytelling with data important?
   o What is the difference between "telling data" and "presenting data"?

II. Understand your target group
- o Who is your target group?
- o What are their needs, desires and challenges?

III. Collect the right data
- o What data is relevant to your story?
- o How can you collect and analyze this data?

IV. Find the right story
- o What message do you want to convey?
- o What metaphor or analogy suits your data best?

V. Design your presentation
- o How can you present your data visually?
- o How can you make your presentation interactive?

VI. Tell your story
- o How can you structure your presentation?
- o How can you get your message across clearly and memorably?

VII. Conclusion
- o What did you learn?
- o What should the audience do or think after seeing your presentation?

5. Code for Binomial Distribution in R

Prompt (Assignment from statistics): Act like a software developer. Write an R function bincoef that calculates n over k without using the function choose (n, k). Write down the function call of the above function so that it calculates the number of possibilities of drawing 6 out of 49 numbers like in a simple number lottery.
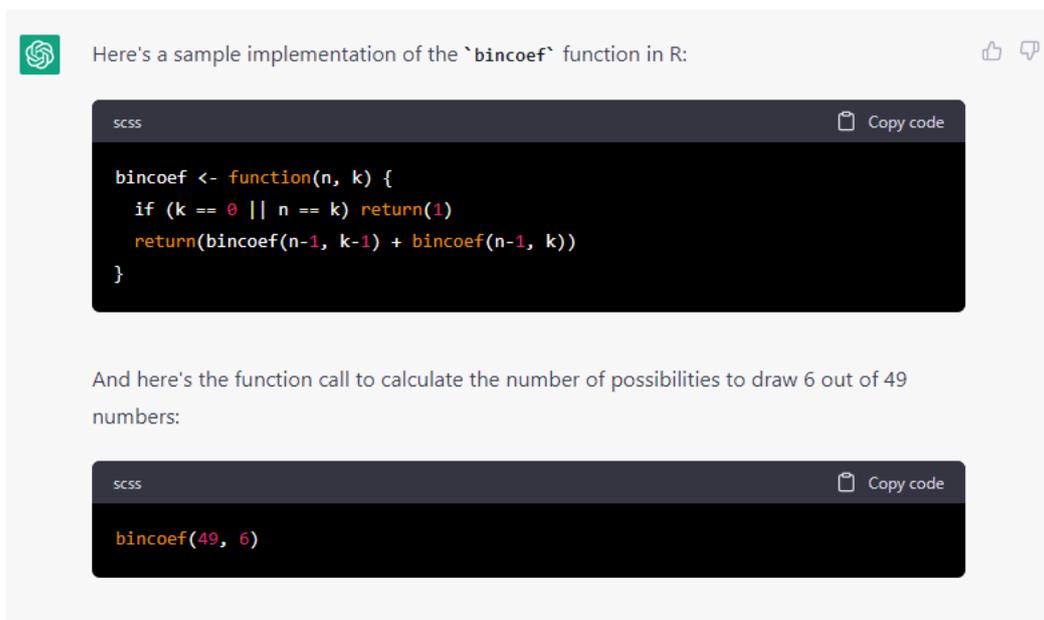
Here's a sample implementation of the `bincoef` function in R:

```scss
bincoef <- function(n, k) {
  if (k == 0 || n == k) return(1)
  return(bincoef(n-1, k-1) + bincoef(n-1, k))
}
```

And here's the function call to calculate the number of possibilities to draw 6 out of 49 numbers:

```scss
bincoef(49, 6)
```

Figure 8: Excerpt from chat session with ChatGPT: Write an R function bincoef.

Further materials and readings

Link to the official page of OpenAI about ChatGPT

Link to an annotated link collection (Hochschulforum Digitalisierung)

Video on the topic "Teaching Philosophy in a World with ChatGPT" (22:08 minutes)

Podcast on the topic "How Artificial Intelligence is Impacting Higher Education" (43:11 minutes)

Position paper by TUM and LMU professors "ChatGPT for Good? On Opportunities and Challenges of Large Language Models for Education"

If you've already had experience with ChatGPT or have any questions about this topic, please feel free to write to us at info@prolehre.tum.de.