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EXAMPLE OF GPT APPLICATION IN THE PROCESS OF STUDENTS' KNOWLEDGE ACQUISITION

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Abstract: The capabilities of various types of artificial intelligence show an intense growth trend, which is accompanied by an increasingly wide range of its applications. This applies especially to GPT. That is why the abilities, but also the shortcomings of this chatbot, as well as the possibilities of its applications, are increasingly in the focus nowdays. In this paper, the authors presented one of the possible models of GPT application in the education of technical students. Through the experiment, the relevance and stability of the answers given by GPT to elementary questions in hydraulics and pneumatics, as one of the fundamental areas on which the knowledge and skills base of a future mechanical engineer is built, were investigated. The stability of the answers was tested using an iterative procedure, and the relevance was determined both by analyzing individual answers and by comparing the answers from all iterations to the same question.

Key words: AI, GPT, hydraulics and pneumatics, JavaScript, algorithms

1. INTRODUCTION

In the last few years, artificial intelligence (AI), with a special emphasis on GPT, is constantly in the focus of the scientific, professional and general public. Possibilities and potentials are discussed, but perhaps even more so, the challenges and dangers of its application. It can be expected that interest in this topic will continue to grow, among other things, because AI will become more accessible to a wider range of users, as well as because the capabilities of AI are expanding and improving at an extraordinary speed. These trends will inevitably be accompanied by complications and abuses that will have to be resolved by new legal regulations and conventions at the global level.

Because of all of the above, the opinions of researchers, users and potential users when it comes to the benefits that AI brings in a very wide range from total rejection to cautious acceptance to already intensive use of numerous options from the more than wide range of possibilities that AI provides. Regardless of which of the mentioned groups a certain person belongs to, it becomes obvious that in the near future it will be impossible to avoid at least some form of AI application. If we are talking about technical students and engineers, it is quite certain that during their studies, but also during their work in practice, they will encounter the need to use some types of AI.

With the intention of supporting the early initiation of targeted and responsible use, the authors of this paper wanted to examine the possibilities of using AI by students for the purpose of learning and preparing for knowledge tests because one of the greatest potentials of this technology could be its use in the educational process [1].

The experiment presented in this paper was carried out in the fields of engineering disciplines of hydraulics and pneumatics, which have a very wide application in practice, especially in automated systems [2] and process engineering. It is necessary to point out that the idea of the experiment was not to test the hypothesis that a student can abandon the classical sources he has relied on in the learning process so far and completely redirect to searching for answers using AI.

In reality, the scenario would actually be: the student checks his preparation for the colloquium / exam by solving a pre-assigned set of questions; then checks the accuracy of his answers by comparing them with class notes and relevant literature recommended by the professor; then he asks the same questions to the GPT and compares the answers he gets with his answers and the answers he found in the conventional literature. The authors wanted to test the possibilities of GPT to serve as a reliable alternative source of knowledge and an assistant to the student in the process of mastering the basics of hydraulics and pneumatics. Next, the authors wanted to examine whether the answers given by the GPT to the repeated set of questions varied in accuracy and scope.

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2. GPT - THEORETICAL BACKGROUND

Over the last few years, more and more different chatbots with functionalities comparable to GPT have become available to potential users. Among others, they are: Google Gemini (formerly known as Bard) [3] and Microsoft Copilot (formerly known as Bing Chat) [4]. For the implementation of the planned experiment, the authors chose GPT, which showed the best characteristics in comparative tests [5].

In this section, authors present the most important concepts related to the experiment, as well as the details of the technical implementation of the experiment. Generative Pre-trained Transformer - GPT is perhaps the most famous Large language model - LLM. LLM are large databases that provide the opportunity to receive answers to questions that are similar in style and quality to answers that a human can provide. "We characterise GPT-4, a large multimodal model with humanlevel performance on certain difficult professional and academic benchmarks. GPT-4 outperforms existing large language models on a collection of NLP tasks, and exceeds the vast majority of reported state-of-the-art systems (which often include task-specific fine-tuning). We find that improved capabilities, whilst usually measured in English, can be demonstrated in many different languages. We highlight how predictable scaling allowed us to make accurate predictions on the loss and capabilities of GPT-4" [6].

This model is based on the advantages that AI gives us: "Artificial intelligence (AI) is technology that enables computers and machines to simulate human learning, comprehension, problem solving, decision making, creativity and autonomy" [7].

We use the GPT-4 version of GPT. GPT-4 provides the possibility to use it through an API, which we used in our work. "An API is a standardized way of interacting with a software application. APIs allow different software applications to interact with each other without having to understand the inner workings of the underlying functions" [8].

The script we used to ask the question is at [9]. The program code is written in the JavaScript language. A prerequisite for using the GPT feature is to create an account on [10]. After creating an account, it is necessary to purchase a certain number of tokens for the operation of the system, because operation in this mode is not free. Another prerequisite is to then create an API key on the system for API access purposes. The API key is entered in the provided place in the script. At the input we send questions in text format, while at the output we receive answers also in text format. The question is entered as a parameter of the ask() method in the script, and the answer is printed in the text console.

3. EXPERIMENT AND RESULTS DISCUSSION

The structure of the experiment consisted of 10 questions (Table 1), of which the first 8 related to introductory concepts from the field of hydraulics and pneumatics (such as the division of fluid power transmission systems, density, compressibility, viscosity, an ideal and a real fluid, etc.), and the last two were simple tasks that required a certain level of reasoning [11]. That structure corresponds to the questions on the first test, which checks the acquisition of elementary knowledge in the field of hydraulics and pneumatics within that subject at the Technical College of Applied Sciences in Zrenjanin. The questions are shown in Table 1. Despite the fact that these questions test basic knowledge, with a deeper analysis it can be determined that a more detailed explanation needs to be given to several questions, and the answers to some questions can be more detailed and broader even though the question itself does not ask for it explicitly. This way, in fact, the experiment imitates a real situation in which a student answers, for example, in an oral exam in a direct conversation with the teacher.

The intention of the authors was not only to test how accurately and precisely GPT will answer the set of questions, but they also wanted to examine the stability of the answers obtained using the iterative method. Therefore, the experiment began on December 18, 2024 at 11:34 p.m. when a set of 10 questions was asked for the first time, and then the experiment was repeated 4 more times with a time interval of 60 minutes, that is, it ended on December 19, 2024. at 03.34 a.m. As is usual in communication with GPT, the person who asks questions is the user, and GPT calls itself assistant when giving answers.

Bearing in mind that listing all sets of answers from the 5 iterations that GPT gave would take up too much space, the authors decided to make the entire experiment (questions and all sets of answers) available. The dataset of our experiment can be seen at [12] and they are available to interested readers. In Table 2, the responses are very concisely presented and compared, and their more detailed comparative analysis is done below. (The symbol "~" placed in some fields of the table means that the answers in that iteration are close to the statement written in that row.)

Table 1 – Questions asked during the experiment

No.	Questions
1	What are the two basic groups of fluid power transmission systems?
2	What two groups of hydraulic power transmission systems are there and how do they differ?
3	At what pressures do pneumatic power transmission systems in industrial applications usually work (in bar)?
4	How is density calculated? Do temperature and pressure affect fluid density?
5	Is the density of the gas determined by the type of gas?
6	What is the difference between compressibility modulus and bulk modulus?
7	How is fluid viscosity defined? What types of viscosity are there and what are their units?
8	Explain the difference between an ideal fluid and a real fluid.
9	An unknown liquid, at normal atmospheric pressure and a temperature of 298.15 K, fills a cube-shaped vessel whose internal dimensions are 1000 mm x 700 mm x 500 mm. The mass of liquid in the container is 0.322 t. Calculate the density of the liquid and determine which liquid it is.
10	If the temperature of the air, which is treated as a real gas and is at a pressure of 1.013 bar, changes from 303.15 K to 333.15 K, determine by how many percent and in which direction the kinematic viscosity of the air has changed.

Table 2 – Comparative answers analysis

<table>
<tr><th></th><th colspan="5">Answers</th></tr>
<tr><th>No.</th><th>Answer 1</th><th>Answer 2</th><th>Answer 3</th><th>Answer 4</th><th>Answer 5</th></tr>
<tr><td>1</td><td colspan="5">The two basic groups of fluid power transmission systems are hydraulic systems and pneumatic systems.</td></tr>
<tr><td>2</td><td colspan="5">The two groups of hydraulic power transmission systems are hydrostatic and hydrodynamic systems.
The explanations differ, but they are correct and have the same essence/meaning.</td></tr>
<tr><td>3</td><td>6 -7 bar, can go as high as 10 bar</td><td>6 - 8 bars, can go up to 10 bars in certain instances.</td><td>6 to 8 bar</td><td>between 4 and 8 bar</td><td>between 6 to 8 bar</td></tr>
<tr><td>4</td><td colspan="5">Density is calculated by dividing the mass of a substance by its volume.
All answers contain the claim that both temperature and pressure can affect fluid density, but they are not equally detailed.</td></tr>
<tr><td>5</td><td colspan="5">Yes, the density of a gas is determined by the type of gas.
Some of the answers also provide additional information.</td></tr>
<tr><td>6</td><td>correct</td><td>contradictory</td><td>correct and more detailed</td><td>incorrect</td><td>correct</td></tr>
<tr><td>7</td><td colspan="5">~ Fluid viscosity is defined as the measure of a fluid's resistance to shear or flow.
Dynamic viscosity and kinematic viscosity.</td></tr>
<tr><td>8</td><td colspan="5">~ An ideal fluid is incompressible and has no viscosity.
A real fluid does have viscosity and can be compressed under pressure.</td></tr>
<tr><td rowspan="2">9</td><td colspan="5">Volume of the cube-shaped vessel is 0.35 cubic meters, the density of the liquid is 920 kg/m³</td></tr>
<tr><td>common types of oil</td><td>a variety of fluids including fuel oil or a specific type of lubricating oil</td><td>density could indicate the liquid is a type of oil</td><td>density matches closely with the density of diesel oil</td><td>density is close to that of SAE 20 motor oil</td></tr>
<tr><td>10</td><td>correct
(close to 18 %)</td><td colspan="3">correct but more complex answer without concrete result
(Sutherland's Law)</td><td>incorrect</td></tr>
</table>

Q1: All five answers to question number 1 are completely identical, which could be expected because the question did not ask for any explanations, but only a descriptive enumeration.

Q2: All five answers to the first part of the question are identical, which could also be expected. All 5 explanations of how hydrostatic and hydrodynamic systems differ are detailed and differently formulated. However, their meanings boil down to the same. Also, it is interesting to note that the responses from the second and fifth iterations give a deeper insight into the pumps used in each of these two systems.

Q3: Based on relevant scientific and professional sources, it can be concluded that the most accurate answer was obtained in the first iteration, but the answers from the second, third and fifth iterations can be tolerated as well [11]. However, the answer obtained in the fourth iteration cannot be accepted because the question contains the word "usually". Namely, in certain specific applications of pressurized air, such as e.g. blowers, work can be done at lower pressures, but those examples do not fall under "usually work" [2].

Q4: All received answers to this question are correct. However, the responses received in iterations 2 and 5 went one step further. On the second part of this question, which read "Do temperature and pressure affect fluid density?", they gave clarifications on how temperature and pressure affect fluid density, even though it was not explicitly asked for in the question.

Q5: All received answers to this question are correct, but the answer received in the second iteration is the best and explains "why" even though it was not explicitly requested: "Yes, the density of a gas is determined by its type, temperature, and pressure. Gases have different molecular weights and as such their densities will vary".

Q6: The answers from the first, third and fifth iterations are identical, with the answer from iteration 3 providing a more detailed explanation and connection between the two terms. The answer obtained in the fourth iteration is completely incorrect because it claims "The compressibility modulus, also known as bulk modulus, measures a fluid's resistance to compressibility. So there's no actual difference between the two; they are essentially the same thing". The answer received in iteration no. 2 is particularly interesting because it is contradictory. At the beginning, the incorrect statement "Compressibility modulus and bulk modulus may seem similar but they are slightly different" is offered. However, the exact definitions of each of these two terms are given below, and finally the connection between them "The inverse of the compressibility modulus is the bulk modulus", which refutes the claim that they are similar but slightly different.

Q7: The answers to this question in all five iterations are correct with some but not significant variations. For example, iterations 1, 3 and 5 claim that "fluid viscosity is a measure of a fluid's resistance to shear or flow", while the answer from iteration no. 2 mentions only "resistance to flow". In iteration 4, the answer "measure of a fluid's resistance to deformation under shear stress or tensile stress" was obtained. In all the answers, the types of viscosity are correctly stated: dynamic and kinematic viscosity. When it comes to their units, in the second, fourth and fifth iteration, the unit for dynamic viscosity is Pascal-seconds and for kinematic viscosity the unit is square meters per second, which is correct. In the first iteration, the exact unit for dynamic viscosity was given, but for kinematic viscosity it was not specified. In iteration no. 3, the exact unit for dynamic viscosity is also given, while for kinematic viscosity, Stokes is given as the unit (the stoke is defined as one centimeter squared per second), so it is assumed that the source was from the Anglo-Saxon area. This unit also represents the square of length/second, such as square meters per second, so this part of the answer in the third iteration is correct.

Q8: All answers to this question are the same and correct, with slight variations that do not change the meaning of the answer.

Q9: It can be seen that in all iterations it is recognized that it is necessary to first calculate the volume of a cube-shaped vessel and only then the density of the liquid in the vessel. All volume values are mutually the same. The liquid density value calculated in all 5 iterations is also identical. The comments made in response to the "determine which liquid it is" part of the question appear to differ. However, the answers from iterations 1 and 3 are actually identical and the most general, while the answer from iteration 2 contains the answers from iterations 4 and 5. It should be noted that none of the answers makes a decisive statement about the type of liquid, but terms such as "could indicate" or "matches closely", which corresponds to reality - it is not possible to unambiguously determine which oil or lubricant we are talking about.

Q10: The answers to this question, which is given in the form of a task, are very interesting. In the first iteration, the answer that the authors expected was obtained ("The kinematic viscosity of air increases with temperature. Without more detailed information about the type of air and its gases composition, one cannot determine the exact percentage of the increase. However, in a general sense, from every 1° C increase, the viscosity of the air increases by about 0.6%, so the increase here would be close to 18%"). However, it should be noted that the kinematic viscosity of different liquids has been experimentally investigated a lot, so the data for the kinematic viscosity at the given atmospheric pressure and temperatures (which are actually 30°C or 60°C) can be found in numerous literature [13]. The authors expected that this data would be found and used by the GPT. The answers obtained in iterations 2, 3 and 4 are actually interpretations that are correct, despite not giving a specific value in percentages, but referring to the need to apply Sutherland's law (an approximation for how the viscosity of gases depends on the temperature). The last answer, obtained in iteration no. 5, is incorrect. This distribution of the answers received to question number 10 may also indicate that it is necessary to correct the task, because it was evidently insufficiently precise for GPT.

4. CONCLUSION

A comparative analysis of the answers to the same questions showed that, when asking the question again, the GPT does not access the same sources to answer the previously asked question. Also, it can be concluded that the accuracy of the answers obtained in all iterations for 9 questions was very high, while problems appeared with the last question. In the student-professor relationship, the student would have the opportunity to ask an additional question and receive the professor's interpretation that would guide him in solving the task. GPT does not ask additional questions to the user, but gives an answer immediately.

The paper shows that GPT, with a solidly high level of reliability, can be used to check answers to theoretical questions that test basic knowledge in hydraulics and pneumatics. When it comes to elementary computational tasks, one should be careful and bear in mind that the success of the solution depends to a considerable extent on the way the task is formulated.

However, when it comes to the application of GPT for educational purposes as promoted in this paper, the authors believe that it should not be frustrating for students that the reliability of the answers is not very high, nor should it discourage them from using AI. It should only arouse caution and teach the student not to trust the GPT unreservedly but to check through at least one other relevant conventional source. The answers and results that GPT offers always need to be checked in some other scientifically relevant way.

Through repeating the experiment in multiple iterations, analyzing the answers obtained and comparing them with the answers found in conventional teaching materials, an additional benefit is realized in the education process, which is a contribution to the development of the student's critical attitude towards the use of AI and the reliability of information and results obtained by its application.

Based on the results of the research presented in this paper, as well as personal experiences and knowledge gained through previous research in this area [1], [13], [14], [15], [16], the authors intend at the Technical College of Applied Sciences in Zrenjanin to introduce expertly guided and encouraged use of AI by students in the process of acquiring knowledge in the teaching of their subjects. The authors are of the opinion that such activities will have multiple benefits for the development of students' knowledge and skills and preparation for future work.

A particular benefit that will be achieved in this way is the encouragement of critical thinking and a critical attitude towards sources of information. Such an approach is necessary to cultivate in future engineers and is specifically important when it comes to GPT (but also other types of AI) because it operates according to the "black box" principle, meaning that we do not know which sources and at what level GPT uses.

On the platform of this work and the knowledge gained so far, the authors see possibilities for future research in the following directions:

- Repeating the performed experiment several times with a time gap of three months to examine whether and to what extent GPT is moving towards reducing errors and omissions, that is, increasing its accuracy. The selected period of repetition of the experiment is so long because, although GPT is very dynamically changing and improving, there is a problem of relevance and homogeneity of the quality of the knowledge base used by GPT. That aspect is also being continuously improved, but experience shows that it needs more time.
- Realization of the same experiment with chatbots such as, for example Google Gemini or Microsoft Copilot. After that, a comparative analysis of the obtained results would be done.
- Conception and realization of the following experiments of the same type from other basic areas of mechanical engineering such as mechanics, resistance of materials and machine elements. The goal would be to compare the obtained results from the aspect of the achieved percentage of accuracy and to get an answer to the question to what extent a student, who is in the learning process, can rely on the answers given by the current version of the GPT.
- Training and moderation of students to, during the process of acquiring knowledge during their studies, realize similar experiments themselves, analyze the obtained results and draw relevant conclusions. Such a process would significantly contribute to raising students' awareness of the possibilities and limitations of GPT and other chatbots.

All the presented insights, with all of the caution that is characteristic of researchers, speak in favor of the fact that it will be increasingly possible to use GPT for similar educational purposes in the near future. Especially because the knowledge base used by this AI will be larger and more relevant, and at the same time its algorithms will be more sophisticated and faster.

5. REFERNCES

[1] Lazić Vulićević Lj.; Eremić, Ž.; Mladenović, V.: Analysis of GPT-4o Application in Solving Simple Static Beams Based on Uploaded Images: Potentials and Limitations, International Conference on Applied Internet and Information Technologies AIIT, November 8, 2024, Zrenjanin, Serbia.

[2] Šešlija, D.: *Automatizacija procesa rada – Pneumatske komponente i sistemi*, Univerzitet u Novom Sadu, Fakultet tehničkih nauka, Novi Sad, 2020, p. 63.

[3] https://zapier.com/blog/google-gemini/, January 2025.

[4] https://www.insight.com/en_US/content-and-resources/glossary/c/copilot.html, January 2025.

[5] https://www.zdnet.com/article/chatgpt-vs-microsoft-copilot-vs-gemini-which-is-the-best-ai-chatbot/, January 2025.

[6] OpenAI (2023). GPT-4 technical report, arXiv preprint arXiv:2303.08774, December 2024.

[7] https://www.ibm.com/think/topics/artificial-intelligence, December 2024.

[8] Di Francesco, H.; Gao, S.; Isola, V., Kirkbride, P.: *Professional JavaScript: Fast-track your web development career using the powerful features of advanced JavaScript*. Packt Publishing, 2019.

[9] https://github.com/ezeljko1981/gpt40-gpt-simple-question, December 2024.

[10] https://platform.openai.com/, December 2024.

[11] Mladenović, V.: *Hidraulika i pneumatika – Zbirka zadataka sa izvodima iz teorije*, Visoka tehnička škola strukovnih studija u Zrenjaninu, 2024, p. 111.

[12] https://drive.google.com/file/d/1mH2NkCYDbzXYgIiUrmOoxsf5E0iUOuzb/view?usp=sharing, December 2024.

[13] Salemović, D.; Mladenović, V.: *Priručnik za hidrauliku i pneumatiku*. Visoka tehnička škola strukovnih studija u Zrenjaninu, 2021, p. 56.

[14] Eremić, Ž.; Mladenović, V.; Šešlija, D.; Halas, D.; Dedić, A.: Istraživanje mogućnosti primene GPT u specifičnim inženjerskim analizama. DIT Naučno stručno informativni časopis 42. pp. 49-58, 2024.

[15] Šešlija, D., Eremić, Ž.; Mladenović, V.; Reljić, V.: CHATGPT and Compressed AIR Quality in Critical Automated Systems. 15th DQM International Conference Life Cycle Engineering and Management, IC-DQM 2024, June 27-28, 2024, Prijevor, Srbija. pp. 38 – 47.

[16] Eremić, Ž.; Mladenović, V.: Primena ChatGPT kao podrška pri rešavanju elementarnih zadataka iz hidrodinamike. DIT Naučno stručno informativni časopis 41. pp. 63-74. mart 2024.