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The impact of ChatGPT on critical thinking

Research paper

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Abstract

The rising popularity of ChatGPT, which led to its integration in various aspects of everyday life, has also raised some concerns about its effects on peoples' critical thinking abilities. The aim of the present research is to examine whether the opportunity of using ChatGPT will affect participants' results of a general knowledge test. Participants were divided into experimental (allowed to use ChatGPT) and control (not allowed to use ChatGPT) groups. Experimental group's total score was lower than control group's. The understanding that AI is prone to errors predicted a higher score in the experimental group, while perceived reliability and understanding of the possibility of oversimplification did not have any effects on the total score. As a result, some negative impact on critical thinking caused by AI was found.

Keywords: artificial intelligence, critical thinking, ChatGPT, research skills

Kokkuvõtte

Suurenenud huvi ChatGPT vastu on soodustanud selle integreerimist erinevatesse igapäevaelu valdkondadesse, millepärast on tekitanud muret seose selle mõjuga inimeste kriitilisele mõtlemisele. Käesoleva uurimistöo eesmärgiks on uurida, kas ChatGPT kasutamisevõimalus mõjutab katseisikute üldteadmistesti tulemusi. Osalejad olid jagatud kahte gruppi – eksperimentaalne (ChatGPT kasutus oli lubatud) ja kontrollgrupp (ChatGPT kasutus oli keelatud). Eksperimentaalgrupi üldskoor oli madalam võrreldes kontrollgrupiga. Arusaam sellest, et tehisintellekt võib eksida, ennustas kõrgema skoori eksperimentaalgrupis, kuid selle tajutud usaldusväärsus ja ülelihtsustamise võimaluse mõistmine ei omanud mõju üldskoorile. Töös leiti, et tehisintellekt avaldas teatud määral negatiivset mõju kriitilisele mõtlemisele.

Märksõnad: tehisintellekt, kriitiline mõtlemine, ChatGPT, uurimisoskused

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Technological progress is an important part of the modern world. It is getting harder and harder to imagine that just around a couple of decades ago, the Internet connection was not as widely accessible as it is today. Just as in many other areas of innovation, technological progress is supposed to make our lives easier, including education, business, government, etc. In this century, the amount of information surrounding us and being received, processed, and interacted with is only increasing. People, especially the younger generation, have a rather positive attitude towards new ideas, inventions, and products. Some of them have gained popularity relatively fast, such as artificial intelligence (AI) powered chatbots, which rely on large language models, with their main advantage being the capability of generating human-like responses (Noorden, 2022). One of the most well-known and widely used chatbots is ChatGPT.

Artificial intelligence is a system's ability to learn from external data and adapt successfully to achieve a certain goal or task (Kaplan & Haenlein, 2019). Therefore, the growing popularity and demand for chatbots might be explained by the fact that they might free people from some resource- and time-consuming activities such as thinking. ChatGPT will find any information for you just upon demand, it can plan a holiday itinerary in seconds, and save you hours writing essays for school. It is also capable of holding multiple conversations at the same time, while still being able to generate responses quickly, therefore is able to produce a lot of information in a short period of time, and its answers are flexible to adjust to one's needs (Kalla et al, 2023). There are many concerns about artificial intelligence nowadays, ranging from privacy and transparency questions to fears of humans slowly being replaced by robots in various life aspects. This paper focuses on the potential threat to human critical thinking skills, which AI-powered chatbots may cause. Critical thinking skills along with creativity, communication, and collaboration are crucial for a human of the 21st century (Spector & Ma, 2019). Those skills are important in decision-making and problem-solving, they help us to adapt to constant changes in the world and distinguish between false and true information.

The findings regarding the impact of AI on critical thinking abilities have been inconsistent. Artificial intelligence certainly has a lot of benefits and opportunities to be implemented into multiple aspects of everyday life. Muthamainnah et al. (2022) analysed self-reported data from students who used AI-based friends (Replika and Mitsuku) to learn English. Students interacted with their AI friends for three months. The study showed a positive impact of AI-based instructions on students' trust, self-confidence, open-mindedness, and maturity, which improved students' critical thinking abilities. Even though the effect is not

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limited only to AI, this technology helps to design appropriate instructions to achieve better learning outcomes. Essien et al. (2024) conducted a study among UK postgraduate business school students featuring two groups: control and experimental. Both groups filled in pre-test to assess their critical thinking abilities, the experimental group then used ChatGPT to help the learning process. Finally, the experimental group underwent a post-test to evaluate critical skills development. Findings suggest that ChatGPT was useful for promoting understanding and application, enhancing analytical and evaluative skills. However, its influence on critical analysis and creative problem-solving is more complex, therefore the usage of AI in learning should be managed carefully to benefit from this tool. In another study by Guo and Lee (2023), the chemistry students had to write an essay with supporting information and references covering the course topic using ChatGPT. The task could be performed either individually or in a group, all of the students completed pre- and post-test as well. According to students' self-evaluation, ChatGPT boosted their confidence to ask insightful questions, helped them to understand complex concepts, and improved their analysing skills. Besides the pros of AI-based chatbots, all of the studies mentioned above emphasise its limitations, which include reliability issues, ethical concerns, and potential misuse of these tools.

Another point of view is that AI-powered chatbots might potentially be responsible for a decrease in thinking abilities, which mostly include critical and creative thinking (Dwivedi et al., 2023). AI chatbots provide answers that are quite logical, understandable, easy, and complex at the same time, so that we do not really need to think independently anymore. However, there are some significant drawbacks such as the accuracy of answers and information provided by artificial intelligence. ChatGPT has some limitations regarding mathematical operations, can easily make conceptual errors, and often oversimplifies information (Tyson, 2023; Darwin et al., 2024). Darwin et al. (2024) conducted semi-structured interviews among English foreign language students to gain insight into the students' perception of critical thinking, perceived benefits of AI in promoting their critical thinking, and perceived limitations and drawbacks of AI regarding critical thinking. Students pointed out the benefits of AI in academic research, theory observation, and experimental design. They also expressed some concerns regarding the lack of personalisation and challenges in nuanced understanding. Thus the development of critical thinking with the assistance of AI-powered chatbots is possible, but requires careful management. Ahmad et al. (2023) found that many cases of human laziness, loss of decision-making abilities along with security and privacy issues are due to the impact of artificial intelligence in Pakistani and Chinese society. They analysed the self-reported data by participants, which measured their beliefs, attitudes, and

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behaviour patterns among variables: AI, decision-making, safety and security issues, and human laziness.

AI chatbots are not perfect and do actually provide users with incorrect information from time to time, and this fact is quite well-known. Kabir et al. (2023) analysed 517 answers to programming questions provided by ChatGPT, the purpose was to examine the correctness, consistency, comprehensiveness, and conciseness of these answers. Findings suggest that 52% of ChatGPT responses contain false information, while 77% of the answers are unnecessarily wordy. However, in some cases, this does not seem to prevent people from relying a little too much on artificial intelligence-powered chatbots, as in Kabir et al. (2023) study 35% of the participants still preferred answers provided by ChatGPT due to its language style and comprehensiveness, 39% of the time the misinformation was overlooked.

The purpose of the current study is to examine whether using ChatGPT has an impact on human thinking abilities and whether this potential impact is positive or negative. The study involved two independent samples – the control and the experimental group. Participants from both groups completed a general knowledge test. The control group was allowed to use search engines, the experimental group used ChatGPT, and search engines if it was needed. All of the questions were tested multiple times with ChatGPT 4o-mini, so it was known that AI answered wrong 7 out of 10 questions. The experimental group could either agree with AI and provide the same answer as it does, or disagree and provide the answer that they think is right. The following hypotheses were examined:

H1: The experimental group will score lower on the test.

H2: Experimental group participants, who find ChatGPT to rather be reliable will score lower on the test.

H3: Experimental group participants, who are aware of the drawbacks of ChatGPT will score higher on the test.

Method

Sample

Participants were university students between the ages 18 and 55. Together 37 participants - 30 women, 5 men and 2 preferred to not specify the gender, have participated in the study. Participants were recruited via social media and students' mailing lists. Psychology students from the University of Tartu were able to earn course credits for their participation.

Research design

The study involved two groups – the experimental group and the control group. Participants were assigned to groups randomly. The test given to both groups was identical in terms of both questions and their order. At the end of the experiment, both groups were presented with a post-test to fill in.

In order to complete the test, the control group was supposed to think independently with the allowance to use web sources, excluding any artificial intelligence chatbots. The experimental group was encouraged to use an AI helping tool (specifically ChatGPT) to complete the test, however, the final answer given to each question did not have to be provided by AI if the participant's opinion was different from the chatbot's one.

Variables

The independent variable was the opportunity to use an AI chatbot available to the experimental group and restricted to the control group. There is some evidence to suggest that the usage of AI tools can lead to increased laziness and decreased ability in decision-making (Ahmad et al., 2023). Thus the availability of AI-powered helping tools is thought to affect critical thinking negatively.

The dependent variable was the influence of the availability of AI helping tool on the process of thinking. The wrong answer percentage in the control group was used as a standard in the population. The amount of wrong answers collected in the experimental group is supposed to demonstrate whether and to which degree AI affects critical thinking. Test questions were designed so that AI is providing wrong answers to the majority of them, although quick research on the Internet would help find correct answers.

The potential confounding variables were personal prejudices and knowledge about AI, as well as previous experience with it. The post-test questionnaire was used to keep these variables under control during the study (see Appendix B). This questionnaire was placed at the end of the survey in order to minimise the potential reactivity of participants. The main

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problem of the study was the potential case of hypotheses being guessed by the participants. In order to avoid this situation, the following steps were done: (1) study design involved two groups, (2) participants were first exposed to the “cover story” of the study goal which was the exploration of different study approaches on problem-solving efficiency. The debriefing was made at the end of the survey after the participants had filled the post-test section.

Some of the questions were inspired by an entertainment TV program “Двое на миллион”. Questions were categorised as general knowledge, therefore do not need any specific field knowledge. All of the questions were controlled using ChatGPT (version 4o-mini) so that it is known whether this tool will give a right or wrong answer. Each question was tested 10 times, and the answer provided by ChatGPT was always either correct or incorrect. The possibility for a right answer to be found by simple research on the Internet was also controlled.

Procedure

To evaluate the possible influence of artificial intelligence on critical thinking the following procedure was done. During the recruitment process, the participants were randomly assigned to one of two possible study groups. The test, as well as the post-test questionnaire, were conducted online via Google Forms. Both experimental and control study groups got the same questionnaire with 10 questions/riddles that do not require specific knowledge to be solved (see Appendix A). Simple web research is enough to find a correct answer.

At the very beginning of the test, participants were guided on whether or not they were allowed to use any materials. The control group was notified that the usage of any AI-powered helping tools such as ChatGPT or similar is not allowed, however, search engines (e.g. Google Search) can be used. The experimental group was told that since the goal of the study is to explore possibilities of collaboration between humans and AI, participants should use ChatGPT 4o-mini while searching for an answer. However, if the participant does not agree with an answer/thinks differently, then they can provide an answer different from ChatGPT. Experimental group participants are also allowed to use Google search if needed.

Each participant had to complete the test individually. Participants were not limited in terms of time. After the test was completed, participants from the experimental group had to fill in a post-test questionnaire in order to map their attitudes towards AI. At the end, participants were provided with a debriefing in order to explain the real idea and hypothesis behind the research. The entire procedure lasted for approximately 45 minutes.

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Ethics

The consent form along with a research description was provided at the very beginning of the test. Participation was voluntary during the entire process; participants were able to deny participation at any time regardless of the research stage. Collected data was saved anonymously and will be deleted after the end of the research.

Upon request, it was possible to receive 0,75 course credits for participation in the survey. There was an extra form to fill in at the end of the test, where participants had to mention their full name and surname along with a university email. This data was collected only to provide professors with the list of participants for confirmation of their participation. The additional collected data was impossible to match with a person's test answers sample.

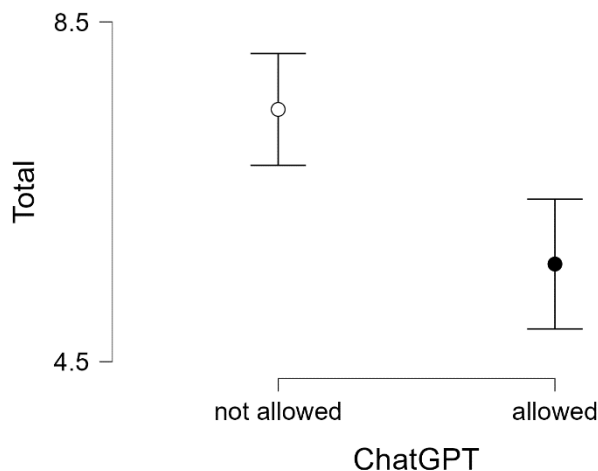
Results

The survey was filled out by 37 people (5 males, 30 females and 2 preferred not to specify the gender) aged between 18 and 55 years old. The following statistical analysis was conducted using Jasp program version 0.19.1.

H1: The experimental group will score lower on the test.

Independent samples t-test was used to compare scores of experimental and control groups. Normal distribution was evaluated using skewness and kurtosis, for the experimental group $skewness=-0.257$, $kurtosis=-0.836$; for the control group $skewness=0.378$, $kurtosis=-0.905$. Overall score of those who were allowed to use ChatGPT during the test was lower ($M=5.650$, $SD=1.631$) than the overall score of the control group ($M=7.471$, $SD=1.281$). There was a significant difference between the two groups $t(35)=3.726$, $p<.001$, $Cohen's\ d=1.229$ (see Figure 1).

Figure 1. Total scores' mean difference.



H2: Experimental group participants, who find ChatGPT to rather be reliable will score lower on the test.

In order to examine hypothesis 2, experimental group participants were divided into two groups according to their answers to which extent they find ChatGPT to be reliable. Answers were given on a 7-point Likert scale (1 - strongly disagree, 7 - strongly agree), therefore answers between 1 and 4 were considered group 1 ($N=11$, $skewness=-0.379$, $kurtosis=-0.404$, $M=5.909$, $SD=1.578$), answers between 5 and 7 were considered group 2 ($N=9$, $skewness=-0.103$, $kurtosis=-0.960$, $M=5.333$, $SD=1.732$). Independent samples t-test indicated that the results were not statistically significant $p=0.447$.

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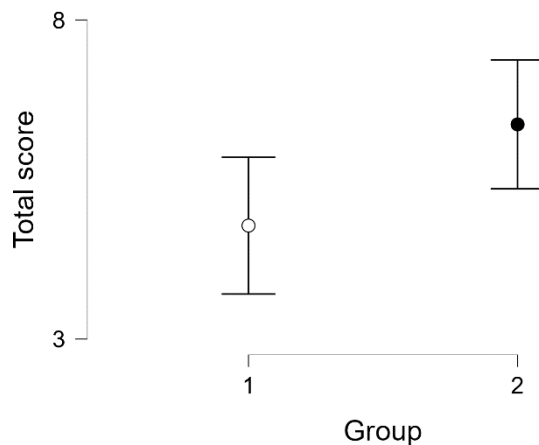
H3: Experimental group participants, who are aware of the drawbacks of ChatGPT will score higher on the test.

Participants rated their attitudes towards two drawbacks of ChatGPT: (1) it often makes mistakes and (2) it tends to oversimplify information. The answers were given on a 7-point Likert scale (1 - strongly disagree, 7 - strongly agree). In case of both statements, two groups were formed depending on to which extent participants agreed with the statement: group 1 (answers between 1 and 4) or group 2 (answers between 5 and 7).

1. “ChatGPT often makes mistakes”

Group 1: $N=9$, $skewness=0.146$, $kurtosis=-1.060$, $M=4.778$, $SD=1.394$. Group 2: $N=11$, $skewness=-0.979$, $kurtosis=1.365$, $M=6.364$, $SD=1.502$. Independent samples t-test indicated a significant difference between the two groups $t(18)=-2.425$, $p=0.026$, *Cohen's d*=-1.090 (see Figure 2).

Figure 2. *The mean difference of the total score of both groups, which were divided based on their assumption whether ChatGPT makes mistakes often.*



0. “ChatGPT tends to oversimplify information”

Group 1: $N=12$, $skewness=-0.351$, $kurtosis=-1.097$, $M=5.167$, $SD=1.403$. Group 2: $N=8$, $skewness=-0.967$, $kurtosis=0.522$, $M=6.375$, $SD=1.768$. Independent samples t-test indicated that the results were not statistically significant $p=0.106$.

In addition to the independent samples t-test above, correlation analysis was used to identify whether the beliefs about ChatGPT and the frequency of using it on a daily basis have an

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impact on the overall score of the experimental group participants. The only statistically significant correlation was found between the total score and the belief that ChatGPT often makes mistakes (see Table 1), which supports the result mentioned above.

Table 1. *Correlation between total score and beliefs and frequency of usage of ChatGPT.*

Variable		Total	1	2	3	4	5	6	7	8	9	10
Total	Spearman's rho	-	-0.049	-0.382	0.453	-0.167	0.356	-0.315	0.119	0.070	-0.248	-0.081
	<i>p</i> -value	-	0.838	0.096	0.045	0.482	0.123	0.176	0.618	0.771	0.292	0.733

Notes: Total - total score, 1 - frequency of usage, 2 - helps to understand complex concepts, 3 - often makes mistakes, 4 - good tool for studying, 5 - oversimplifies the information, 6 - good for conducting analysis, 7 - improves creativity, 8 - saves a lot of time, 9 - is reliable, 10 - is a useful tool

Discussion

Since its launch, ChatGPT has rapidly gained popularity among people, especially university students, due to the chatbot's ability to solve problems, explain complex concepts as well as make research faster and easier along with maintaining a human-like conversation. Besides its advantages, the model still faces some limitations, such as oversimplifying the information, lack of common sense, and the possibility of bias (Rahman & Watanobe, 2023).

The present study found that the opportunity to use ChatGPT during the test resulted in a lower overall score in the experimental group. This might be connected to one of the risks large language models possess. Since the model simplifies the answer's research process, it might support users' laziness in conducting an additional investigation to solve the initial problem (Kasneci et al, 2023). Moreover, as many people regard tools such as ChatGPT as time-saving, this may lead to the initial intention to spend as little time as possible to gain any information, which results in poor further investigation on the topic or its complete absence. Poor research might lead to misinterpretation and therefore misleading conclusions. The probability of such outcomes only arises when fully relying on ChatGPT as it has some major problems with literature review. The tool can summarise information, but lacks the consistency and ability to combine information from various sources. Moreover, it often provides non-existent sources and citations (Rahman et al., 2023), which may result in the spread of misinformation. Such outcomes are especially dangerous if discussed in specific fields (ex. Slowing or misleading progress in technology, leading to failure in business). In contrast, Li et al. (2024) found that the research skills of the study participants were not directly affected by the usage of ChatGPT. However, the students in that study were specifically trained to provide effective prompts and rate the credibility of the answers provided. This means that AI-powered chatbots can in fact be beneficial for critical thinking skills, supporting students' autonomous motivation and engagement in the study process, but only if the model is used right.

The degree of perceived overall reliability of ChatGPT did not have any significant effect on participants' total scores. In a study by Huschens et al. (2023), where participants had to rate the trustworthiness of content generated by humans and large language models, people, in fact, did not perceive AI-generated content as being less credible, regardless of the form, in which it was presented. It might be possible that regardless of people's knowledge about the downsides of ChatGPT such as its possible errors and hallucinations, a particular answer might be seen as more reliable, and thus additional investigations might be regarded as unnecessary. Another finding by Liang et al. (2024) suggests that people prefer to use social cues to assess

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the credibility of information provided by ChatGPT and rarely engage in alternative verification methods unless social cues are insufficient.

The participants' awareness of possible oversimplification of information by ChatGPT also did not have any significant effect. The problem with many information sources, and especially scientific papers, is the complexity of the language they are written in. Van Raaij et al. (2024) found that ChatGPT helped to increase the comprehensibility of governmental text by 20%. Huschens et al. (2023) found that AI-generated texts were found to be clearer, and therefore, easier to understand, thus participants spent less time reading them. This aspect, again, requires some critical thinking skills in the first place to assess whether the provided information is sufficient and depicts fully the research question. Therefore, the population with lower literacy is at risk of relying on the content of AI-powered chatbots (Oviedo-Trespacios et al, 2023), because they might not be able to fully assess the information provided from various aspects.

Participants' awareness of the possibility of mistakes in the information provided by ChatGPT did have a significant effect on the total score. This aspect can actually be beneficial in terms of critical thinking, which includes analysis of the information provided and usage of different tactics to obtain a trustworthy answer. However, it is important to note that evaluation of the answer itself requires some critical thinking skills, in the first place. In addition to research through alternative sources of information, it is possible to obtain a better answer by ChatGPT by providing a better prompt, which was demonstrated in findings by Li et al. (2023). Kim et al. (2024) described four categories of users' tactics to deal with dissatisfaction with information provided by AI-powered chatbots. Those tactics include prompt reusing (paraphrasing, using more inputs, adding emphasis through formatting), intent concretisation (providing detailed/direct instructions, additional context and/or explanation, adding format-specific or tone-specific conditions), error identification/correction (pointing out errors, providing hints, clarification questions), and task adaptation (breaking the original task into subtasks, asking follow-up questions, adapting by shifting to another topic/task). Nori et al. (2023) explored prompt engineering methods creating a composition of those strategies, which allowed to reduce an error rate by 27%.

Limitations

The current study was limited in terms of the number of participants, which stayed low. Small sample might lead to poor generalisability in the population and overestimate the effect size. What is more, the method focused more on research skills, creativity, and evaluation of

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information, which are certainly important components of critical thinking. However, there are other critical thinking aspects such as adaptation, problem identification, observation, etc. that might be affected by the frequent usage of AI-powered chatbots like. Since models such as ChatGPT provide fast, easy, and understandable solutions, it might negatively affect practice and even the development of reflection and reasoning skills. Therefore it is important to consider other skills that are at risk when excessive usage and dependence on AI-powered chatbots takes place.

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Appendix A. Test questions

1. At the end of the year, before the festive season, the famous supermarket chain "Tesco" was hiring people to do this job. The performance required was "3 meters under 3 minutes". What is the job?
2. Italian charity organisation "Caritas" gets lots of money every year from this source, it can be said that many tourists donate to this organisation while coming for a vacation in Rome. What is this source?
3. In the 1960s, John Shepherd-Barron came to the bank but was late so the building closed its doors for the day. Later he invented this thing, which solved the problem of bank being closed. What was it?
4. The 22nd and 24th presidents of the US were not brothers, but they had the same parents, how is it possible?
5. One pharmacist invented this for his sister Mable in 1913, so she could stop using Vaseline and coal dust for this purpose. What was it?
6. What flower is the national symbol of Japan?
7. In the film Matrix, we saw a computer code in a form of digital rain, what was the meaning of this code?
8. People call it "Dad's beard" in French, "Grandmother's hair" in Bulgarian, what is it?
9. Transport for London made 2 million pounds in three years, but not from selling tickets. How did they earn money?
10. In Japan, some people have to pass an unusual test to get this job. The test involves origami skills and making sushi from one rice grain. What is the job?

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Appendix B. Post-test questionnaire

1. How often do you use ChatGPT or a similar tool?
2. What do you use it for?

The following statements were evaluated using a 7-point Likert scale (1 – strongly disagree, 7 – strongly agree):

3. ChatGPT helps to understand complex concepts.
4. ChatGPT often makes mistakes.
5. ChatGPT is good for studying.
6. ChatGPT tends to oversimplify the information.
7. ChatGPT is good for conducting analysis.
8. ChatGPT helps to improve creativity.
9. ChatGPT saves me a lot of time.
10. I find ChatGPT to be reliable.
11. Overall, I find ChatGPT to be a useful tool.

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Käesolevaga kinnitan, et olen korrekselt viidanud kõigile oma töös kasutatud teiste autorite poolt loodud kirjalikele töödele, lausetele, mõtetele, ideedele või andmetele.

Olen nõus oma töö avaldamisega Tartu Ülikooli digitaalarhiivis DSpace.

Anna Bugvina