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Artificial Intelligence in studies—use of ChatGPT and AI-based tools among students in Germany

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AI-based tools such as ChatGPT and GPT-4 are currently changing the university landscape and in many places, the consequences for future forms of teaching and examination are already being discussed. In order to create an empirical basis for this, a nationwide survey of students was carried out in order to analyse the use and possible characteristics of AI-based tools that are important to students. The aim of the quantitative study is to be able to draw conclusions about how students use such AI tools. A total of more than 6300 students across Germany took part in the anonymous survey. The results of this quantitative analysis make it clear that almost two-thirds of the students surveyed use or have used AI-based tools as part of their studies. In this context, almost half of the students explicitly mention ChatGPT or GPT-4 as a tool they use. Students of engineering sciences, mathematics and natural sciences use AI-based tools most frequently. A differentiated examination of the usage behaviour makes it clear that students use AI-based tools in a variety of ways. Clarifying questions of understanding and explaining subject-specific concepts are the most relevant reasons for use in this context.

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Introduction

Artificial intelligence (AI) is a key technology with the potential to fundamentally change entire markets, industries, business activities and business models (von Garrel et al., 2022). Since November 2022, the topic has reached a new level of attention when the US company Open AI published ChatGPT, an AI-supported computer model for language processing, which reached millions of users worldwide after only a few days (Janson, 2023). This was followed on 14 May 2023 by the launch of ChatGPT-4, which can process both text and image input, including text documents, photos, diagrams, or screenshots, and which, according to the manufacturer, performs on a human level in various professional and academic benchmarks (OpenAI, 2023a).

The possibilities for the use of such AI tools are manifold. In the business context, such AI tools could be used, for example, in interactions with customers, internal service organisation or in the recruitment of new employees (Kohne et al., 2020). In the scientific context, such tools can support text analysis, translate texts, or even write abstracts for research papers (Berdejo-Espinola and Amano, 2023). In addition, the first publications already exist in which such tools are listed as co-authors (Stokel-Walker, 2023). In the field of education, these tools could support pupils and students to reflect on scientific practices, to optimise their texting, to have texts proofread or even to act as tutors for exam preparation (Marx, 2023). However, these opportunities are also countered by risks—from security concerns to misinformation to a lack of scientific rigour (Albrecht, 2023). Open AI, for example, admits that ChatGPT can sometimes generate plausible-sounding, but erroneous and incorrect answers (OpenAI, 2022). Furthermore, with regard to use, there are risks in the collection of usage data, the more difficult assessment of the results, the unclear authorship, as well as the unreflective and abusive use of chatbots (Mohr et al., 2023). As a consequence, individual countries have temporarily banned the use of the tool (e.g. Italy); organisations (including Samsung, JPMorgan) or schools and educational institutions have also restricted and continue to restrict the use of AI-based tools by their employees or pupils or students (Hughes, 2023; Lukpat, 2023).

Especially against this background, initial empirical studies already exist that analyse the use of AI-based tools in various contexts, but there is no Germany-wide study of the use of such AI systems by students in the context of studying and teaching. The aim of this report is therefore to analyse the use of AI-based systems in studies. To this end, a survey of students enroled at a German university at that time was conducted between 15 May 2023 and 5 June 2023.

In order to meet this objective, this report is divided into five sections. After the first introductory section, the next section briefly presents the basic theoretical as well as empirical state-of-the-art. The next section then presents the methodological approach and a brief overview of the limitations of this study. The next section presents the descriptive results of the study. The penultimate section reflects on the entire procedure with regard to the quality criteria of objectivity, reliability and validity. The last section concludes the documentation with a conclusion and outlook.

State of the art

The term artificial intelligence is not universally defined, not least because the understanding of AI evolves with technological progress and the concept of intelligence itself is very complex and therefore cannot be clearly delineated (e.g. Federal Government of the Federal Republic of Germany, 2018). In addition, AI is a multi- and interdisciplinary subject area and can therefore be studied from different perspectives (Lu, 2019). Although the term AI has its origins as early as the 1950s, the eminent advances in the performance of computer systems, the quality of algorithms and the availability and storage of data in recent years have significantly accelerated the further development and possible applications of AI in many areas. Artificial intelligence refers to methods, processes and technologies that enable IT systems, such as machines, robots or software systems, to interpret large amounts of data and to learn from this data in order to emulate or imitate certain human cognitive abilities (e.g. Di Vaio et al., 2020). In this way, tasks that require visual perception, language or strategic thinking and planning, for example, can be carried out independently and efficiently by IT systems.

Overall, this makes it clear that the diversity of possible AI systems is great. In order to do justice to this diversity of possible areas of application, fields of use and designs of AI-based tools, various approaches exist for reducing complexity and structuring. In this report, the structuring of artificial intelligence according to von Garrel et al. (2022) is followed and the following morphological box can therefore be used to approach the concept of AI-based tools for teaching and learning (Table 1).

In the context of studying and teaching, cognitive systems in particular, which focus on informational work and thus also information as an object, seem to be highly suitable. Such AI-supported computer models for language processing are often based on artificial neural networks, which enable an efficient conversion of language into mathematical parameters and thus allow a high level of complexity and large amounts of data to be processed (Albrecht, 2023). In the first step, the system independently processes large quantities of texts and forms parameters from them—the ChatGPT model, for example, comprises 175 billion parameters (Albrecht, 2023). The system can then use human feedback to fine-tune a specific task and convincingly imitate a wide variety of text types at high speed (Albrecht, 2023).

The impact of such AI-based tools in society, business and science can be significant. A recent study by OpenAI concludes that for about 80% of the US workforce, at least 10% of their work tasks could be affected by the introduction of their AI-based tools. For nearly one-fifth of workers, at least 50% of tasks could be impacted (Eloundou et al., 2023).

Even though the above morphology clearly depicts possible functions of AI-based tools, a concrete list of possible uses of AI-based tools in studies across disciplines and as complete as possible cannot be found. An analysis reveals the following possible uses for students:

"Research and literature study".
"Text analysis, text processing and/or text creation".
"Programming and simulations".
"Exam Preparation".
"Language processing".
"Clarification of comprehension questions and explanation of subject-specific concepts".
"Translations".
"Research and literature study".
"Concept development (including project designs) and/or design".
"Problem solving and decision making".
"Data analysis, visualisation and modelling".
"Teacher training".

As described, however, these tools have characteristics (including the generation of misinformation) that cast doubt on their uncritical use in the field of teaching and learning. For example, Open AI admitted at the initial launch of ChatGPT that the chatbot sometimes generated plausible sounding but incorrect

Table 1 Morphology of AI-based systems (based on von Garrel et al., 2022).

Key features	Characteristics					
Function	Data aggregation & filtering	Optimisation	Planning	Information enrichment and processing	Communicating	
	Forecast	Argumentation/Conclusion/ Justification	Search	Learning	Awareness/Recognition	
Data perception	Audio	Video	Digital	Smell	IoT (sensory data)	Statistical data, sample
Subject	Materials	Goods	Information	Data carrier	Other objects	
Activity type	Energetic work				informational work	
Type of work	Mechanically	Motor	Reactively	Combinatory	Creatively	
Autonomy level	No support/human decides	Action support/assisted decision-making	Decision support/partial decision-making	Mixed/reviewed decision	Automated/delegated decision making	Complete automation/autonomous decision-making
Form of presentation and interaction	Physical system available (hardware)			(Pure) Cognitive System (software)		
	Classical	Collaborative	Machine	Conventional application	Immersive application (MR, AR, VR)	
	Mobile		Stationary			
Social preference	Computer-mediated communication				Man–machine interaction	
Explainability/ transparency	None (decision of the algorithm is presented without explanation)		Low (user receives data as a basis for decision-making)		High (user receives an explanatory/(visual) conclusion of the algorithm based on the underlying data)	
Interactivity	Static, no adjustment of interaction		AI can adapt to humans through interaction with the employee		Can autonomously adapt to individual users in a personalised way through interaction with humans	

and faulty answers (OpenAI, 2022). The latest version, GPT-4, is said to be more reliable, more creative, and also able to process more sophisticated instructions than the previous version (OpenAI, 2023b). Nevertheless, the new version has similar limitations to previous models and is not yet completely reliable, as facts are "hallucinated" and errors in thinking are made (ibid.). Open AI advises exercising great care when using the chatbot in contexts where demands are high or the stakes are high, or to refrain from using it altogether (OpenAI, 2023a).

Since such AI tools can thus produce false, misleading, unethical, discriminatory, or socially unacceptable results, which can result from existing prejudices during technical development, poor data quality or inadequate modelling, among other things (Strauß, 2021), an uncritical and unreflective use of AI tools in the field of study & teaching is risky. In this context, the following table provides an overview of relevant properties of AI-based tools for use in teaching and learning from the perspective of current publications from theory and practice (including Berger and von Garrel, 2022; OpenAI, 2023a; Kohne et al., 2020; Krüger, 2021; Jahn, 2023; Neu et al., 2022) (Table 2).

In addition to this theoretical-conceptual approach to the topic, empirical studies have been conducted on the use of AI-based tools in general and ChatGPT and GPT-4 in particular. An analysis that has been carried out since the launch of ChatGPT shows, among other things, the following empirical studies in an international context:

- Ali et al. (2023)
- Choudhury and Shamszare (2023)
- Firaina and Sulisworo (2023)
- Forman et al. (2023)
- Hosseini et al. (2023)
- Sakirin and Said (2023)
- Skjuve et al. (2023)
- Strzelecki (2023)
- Zhang et al. (2023)

As a brief conclusion, it can be said that both in the theoretical and empirical context, usage behaviour with regard to AI-based tools (and ChatGPT in particular) is highly relevant as an object of observation. However, there is no national study on the

Table 2 Relevant properties of AI-based tools for use in teaching and learning.

Category	Characteristics
Interaction	Adaptation of the interaction to the user (e.g. personalised adaptation to previous chat history)
	Error detection/correction during input (e.g. grammar)
	Error prevention during output (e.g. misinformation)
Reasoning	Degree of scientificity (e.g. citation/source citation)
	Explainability of the decision (e.g. comprehensibility of the results)
	Logical reasoning
Usability	Learning ability (e.g. AI learns from chat histories)
	Communication with the system (e.g. colloquial vs. technical language)
	User interface (e.g. clarity)
	Possibilities of interactive input (e.g. input in text, language, image)
	Possibilities of interactive output (e.g. output in text, language, image)
	Size of the output (e.g. 10, 20, 50, 80 pages output)
	Extent of input (e.g. 1, 2, 5, 10 pages of input)
Safety	Consideration of safety protocols (e.g. age restrictions)
	Consideration of ethical standards (e.g. no discrimination)
	Degree of data protection (e.g. handling of personal data)

concrete usage behaviour and relevant characteristics of the use of these tools among students, as intended in this report.

Methodical approach

In order to meet the objective of the study, a quantitative survey is conducted by means of an online questionnaire. The survey includes a questionnaire on the general topic of the use and intensity of use of AI-based tools for studying, as well as a choice-based conjoint experiment (CBC) (see Appendix). In the CBC, the participants have to make 8 fictitious purchase decisions, each choosing from two offers. A question is then asked explicitly about the characteristic(s) that are most important to the students in their evaluation. For this purpose, the 15 characteristics presented in the section "State of the art" were evaluated in terms of relevance within the framework of a preliminary study with 36 students from various disciplines. The self-explicated method was used to identify the five most relevant characteristics from the students' point of view. The results show that the most relevant features for the use of AI-based language tools are error avoidance during output ($M = 85.86$, SD = 19.10), the degree of scientificity ($M = 85.11$, SD = 22.31), logical reasoning ($M = 83.58$, SD = 17.25), explainability of the decision ($M = 81.69$, SD = 20.39) and error detection/correction during input ($M = 71.00$, SD = 32.69). The characteristic expressions that were identified in the context of the self-explicated method have been revised again to ensure the comprehensibility of the designations.

A questionnaire on the general topic of the use of AI-based tools for studying forms the second section. Before the survey was sent out, a pre-test was carried out. This survey is a self-selection sample (Döring and Bortz, 2016, p. 306), which is addressed indirectly to students from different German universities. The general call for participation was sent to contact persons at the respective universities, with the request that they forward it to the students.

There are currently a total of 423 universities in Germany (DESTATIS, 2023a; Hochschulkompass, n.d.), of which 395, or 93%, could be contacted. For those universities that could not be contacted, no contact address could be identified. Private higher education institutions were primarily affected by this.

The contact persons were selected deliberately and systematically via the websites of the respective universities with the aim of identifying study programme coordinators for each study programme. In this way, a total of 3,849 programme coordinators from 395 different higher education institutions and universities could be contacted. Among the persons contacted are 2739 professors and 1110 other persons with an administrative function (Table 3).

Overall, the study has some limitations, which will be briefly discussed:

- *Methodological procedure*: Due to the methodological procedure, this is a non-probabilistic sample, as the selection of the survey elements is not randomised. This is associated with limited representativeness compared to probabilistic samples, but it is still possible to work with non-probabilistic samples in the context of exploratory studies, as the focus here is not on the precise estimation of population parameters. Rather, exploratory studies are concerned with the formation of theories about cause-effect relationships and their testing with regard to their degree of validity (Döring and Bortz, 2016, p. 301ff.).
- *Titling of the study*: The emails are sent with the title "ChatGPT use in studies: invitation to a short scientific study". In this context, the "hype" around ChatGPT is thus also deliberately included. Due to the double selection step in accessing the sample, bias may occur here, as this title may particularly address colleagues at universities as well as students who have an affinity with the topic.
- *Language of the questionnaire*: The questionnaire is only available in German, as it focuses on the target group of students who are enroled in Germany. Students (and possibly colleagues) who are not fluent in German may therefore be limited in their ability to participate in the survey.
- *Understanding of AI*: The study focuses on an analysis of the use of AI-based tools. ChatGPT" is mentioned in the title. The greeting also refers to "AI-based tools (e.g. ChatGPT, DeepL, DALL-E)" and "AI-based language tools, such as ChatGPT". Here, too, a bias may result from a possible dominance in favour of a high degree of use of the tool "ChatGPT/GPT-4".
- *Self-assignment to a field of study*: The study deliberately aims at the use of AI-based software among students who are enroled in Germany and claims to consider all fields of study. The classification of study areas according to the Federal Statistical Office is followed (DESTATIS, 2023c). The allocation in these statistics follows the information provided by the higher education institutions. Within the scope of the study, an allocation of the degree programme is made by the students themselves. Here, too, a bias can result such that certain fields of study (e.g. humanities) are misinterpreted or the allocation of certain study programmes (e.g. computer science to the field of engineering) is not clear to the students. In addition, interdisciplinary degree programmes are becoming increasingly important, so that their allocation to a field of study (e.g. industrial engineering to the field of study "engineering" or "law, economics and social sciences") is also uncertain.
- *Social desirability*: Even if anonymity is guaranteed in the survey and this is also explicitly stated several times, social desirability—i.e. the conscious or unconscious falsification of answers in order to avoid rejection, criticism or social sanctions—can also lead to a distortion of the results.
- *Background of use*: Since, as described, the topic has a high public relevance and the use is discussed in particular in the context of studying and teaching from the perspective of both students and teachers, the use of AI-based software can also result from induction by the university itself and thus the use of AI-based software can be regarded as a methodological-didactic instrument induced by the teachers.

Table 3 Universities and persons addressed.

Addressed	Total	Professorial	Administrative
Universities addressed	395		
Persons addressed	3849	2739	1110
Deans	546	425	121
Associate Deans	371	351	20
Deans of Studies	764	706	58
Study programme directors	576	521	55
Coordinators	233	66	167
Other directors	365	223	142
Secretariats	45	0	45
Others	949	447	502

Results

Population and Sample. The population of the survey includes all persons enroled at a German higher education institution or university at the time of the survey.

Table 4 Distribution of the sample by gender.

Gender	Sample		Population[a]	
	abs.	%	abs.	%
Male	2132	33.8		
Female	3807	60.3	1,475,444	50.6
Diverse	82	1.3		
Not specified	290	4.6		
Total	6311	100.0	2,915,714	100

[a]DESTATIS (2022).

According to preliminary figures, a total of 2,924,276 students were enroled at German higher education institutions in the winter semester 2022/2023 (DESTATIS, 2023b). The number of students in Germany is thus currently around 2.9 million. Of these, 12% study in Baden-Württemberg, 14% in Bavaria, seven percent in Berlin, 2% in Brandenburg, 1% in Bremen, 4% in Hamburg, 9% in Hesse, 1% in Mecklenburg-Western Pomerania, 7% in Lower Saxony, 26% in North Rhine-Westphalia, 4% in Rhineland-Palatinate, 1% in Saarland, 4% in Saxony, 2% in Saxony-Anhalt, 2% in Schleswig-Holstein and 5% in Thuringia (DESTATIS, 2023b). Eleven percent of students in Germany study humanities, 1% study sports, 39% study law, economics, and social sciences, 11% study mathematics and natural sciences, 7% study human medicine and health sciences, 2% study agriculture, forestry and nutrition, 26% study engineering and 3% study arts and art sciences (DESTATIS, 2023c).

The characteristics of the federal state and subject group are collected as part of the survey in order to be able to make statements about the characteristic-specific representativeness (Döring and Bortz, 2016, p. 298) of the sample.

A total of 8802 responses were recorded in the survey. 363 persons did not consent to data protection, 115 persons stated that they were not enroled at a German university and 1973 persons did not complete the survey. Those cases are filtered out, leaving a sample size of 6311 cases.

There were 3807 females, 2132 males, and 82 miscellaneous persons who participated in the survey. 138 persons did not indicate their gender. The proportion of female persons (60.3%) thus deviates from the basic population. According to provisional figures, 50.6% of students were female in the winter semester 2022/2023 (DESTATIS, 2022). The average age of the students in the sample ($M = 24.21$, $SD = 5.07$) is slightly above the average age of the population. Thus, students in Germany were on average 23.5 years old in the winter semester of 2021/2022 (DESTATIS, 2023b) (Table 4).

Of the respondents, 36% are studying subjects in the fields of law, economics, and social sciences. 20% of the respondents study humanities, 17% engineering, 9% mathematics and natural sciences, 8% human medicine or health sciences, 5% arts and art sciences, 1% agricultural, forestry and nutrition sciences or veterinary medicine and 1% sports. 4% of the respondents studied other subjects or could not be clearly assigned to any of the fields (Table 5).

The majority of respondents study in Bavaria (17%), North Rhine-Westphalia (17%), Hesse (15%), Bremen (13%) and Baden-Württemberg (12%). Another 7% study in Rhineland-Palatinate, 5% in Thuringia, 5% in Hamburg, 2% in Mecklenburg-Western Pomerania, 2% in Saarland, 2% in Saxony-Anhalt, and 1% each in Schleswig-Holstein, Berlin, Brandenburg, Saxony and Lower Saxony (Table 6).

Use of AI-based tools as part of the study programme. The central issue of the study focuses on the use of AI-based tools by students. Overall, almost two-thirds (63.4%) of the students surveyed state that they have used AI-based tools for their studies.

Table 5 Distribution of the sample as well as the population according to fields of study.

Fields of study	Sample		Population[a]	
	abs.	%	abs.	%
Engineering	1083	17.2	765,405	26.2
Human Medicine/Health Sciences	497	7.9	201,258	6.9
Humanities	1231	19.5	312,205	10.7
Law, economics and social sciences	2294	36.3	1,126,170	38.5
Mathematics, natural sciences	570	9.0	315,473	10.8
Agricultural, forestry and nutrition sciences, veterinary medicine	85	1.3	62,927	2.2
Arts, art sciences	291	4.6	101,483	3.5
Sports	32	0.5	30,400	1
Other subjects and unexplained	223	3.5	8955	0.3
Total	6306	100.0	2,924,276	100

[a]DESTATIS (2023c).

Table 6 Distribution of the sample as well as the population according to federal states (seat of the university).

Federal state	Sample		Population[a]	
	abs.	%	abs.	%
Baden-Württemberg	732	11.6	354,690	12.1
Bavaria	1085	17.2	403,437	13.8
Brandenburg	63	1.0	198,429	6.8
Berlin	73	1.2	50,443	1.7
Bremen	833	13.2	37,393	1.3
Hamburg	298	4.7	119,714	4.1
Hesse	919	14.6	256,216	8.8
Mecklenburg-Western Pomerania	119	1.9	38,363	1.3
Lower Saxony	34	0.5	197,983	6.8
North Rhine-Westphalia	1039	16.5	750,501	25.7
Rhineland-Palatinate	464	7.4	117,009	4.0
Saarland	93	1.5	30,968	1.1
Saxony	36	0.6	106,125	3.6
Saxony-Anhalt	93	1.5	58,377	2.0
Schleswig-Holstein	84	1.3	66,150	2.3
Thuringia	342	5.4	138,478	4.7
Total	6307	100.0	2,924,276	100.0

[a]DESTATIS (2023b).

A detailed analysis of the degree of use shows that every fourth student (25.2%) uses AI-based tools (very) frequently, while almost half of the students (47.8%) use AI-based tools (very) rarely or occasionally. Slightly more than a third of the students (36.6%) do not use AI-based tools at all. With a mean value of 2.93 ($SD = 1.961$), the overall picture of use is diffuse (Table 7).

If we now look at the intensity of use subdivided according to the fields of study, differences become clear. The highest usage values are found in the engineering sciences as well as in mathematics and the natural sciences. More than three-quarters (75.3%) in engineering, almost three-quarters in arts and humanities (73.4%) and over 70% (71.9%) in mathematics and natural sciences of the students surveyed use these tools. More than half of the students also use AI-based tools for studies in the humanities (61.0%), law, economics, and social sciences (58.4%) in human medicine and health sciences (52.7%). In the agricultural, forestry and nutrition sciences, as well as veterinary medicine, the figure is slightly below half of the students (47.6%). It should also be emphasised that 87.5% of students in the field of

Table 7 "I use AI-based tools for studying" (Likert scale).

AI use for study	abs.	%	*M*	SD
			2.93	1.961
Not at all (1)	2308	36.8		
Very rarely (2)	999	15.9		
Rarely (3)	786	12.5		
Occasionally (4)	599	9.5		
Frequently (5)	188	3.0		
Very often (6)	1398	22.3		
Total	6278	100.0		
$N = 6311$				

Table 8 "I use AI-based tools for studying" (dichotomised, broken down by field of study).

AI use for study	abs.	%	*M*	SD
Engineering			3.46	1.932
Yes	813	75.3		
No	265	24.6		
Total	1078	100.0		
Human Medicine/Health Sciences			2.62	1.946
Yes	259	52.7		
No	232	47.3		
Total	491	100.0		
Humanities			2.81	1.954
Yes	745	61.0		
No	477	39.0		
Total	1222	100.0		
Law, economics and social sciences			2.73	1.933
Yes	1336	58.4		
No	952	41.6		
Total	2288	100.0		
Mathematics, natural sciences			3.22	1.958
Yes	409	71.9		
No	160	28.1		
Total	569	100.0		
Agricultural, forestry and nutrition sciences, veterinary medicine			2.55	1.978
Yes	40	47.6		
No	44	52.4		
Total	84	100.0		
Arts, art sciences			3.22	1.927
Yes	212	73.4		
No	77	26.6		
Total	289	100.0		
Sports			3.25	1.723
Yes	28	87.5		
No	4	12.5		
Total	32	100.0		
Other subjects			2.63	1.895
Yes	126	56.8		
No	96	43.2		
Total	222	100.0		
$N = 6311$				

sport use the programme. With a response rate of $n = 28$, however, the question of the validity of this value should be noted here. In the other fields of study, slightly more than half (56.8%) of the students use AI-based tools (Table 8).

An analysis of usage behaviour according to the degree pursued makes it clear that the proportion of students who use AI-based tools as part of their studies is higher in the Master's programme ($M = 3.30$, SD = 1.972) than in the Bachelor's programme ($M = 2.99$, SD = 1.965) or as part of a doctoral programme ($M = 2.65$, SD = 1.990). In the Master's degree, more than 70% (71.7%), in the Bachelor's degree almost two-thirds (65.0%) and in doctoral degree programmes slightly more than half (51.9%) of the students surveyed use AI-based tools; for other degrees, the rate is slightly below half of the respondents (49.1%).

Table 9 "I use AI-based tools for studying" (dichotomised, broken down by gender).

Gender	AI use for study	abs.	%	*M*	*SD*
Female				2.77	1.941
	Yes	2254	59.6		
	No	1528	40.4		
	Total	3782	100.0		
Male				3.19	1.969
	Yes	1467	68.9		
	No	661	31.1		
	Total	2128	100.0		
Diverse				2.82	1.893
	Yes	51	62.2		
	No	31	37.8		
	Total	82	100.0		

Table 10 "Which AI-based tools have you already used?" (Open question, multiple answers possible).

AI-based tools used	abs.	%
ChatGPT	3083	48.9
DeepL	779	12.3
DALL-E	227	3.6
Midjourney	163	2.6
BingAI	114	1.8
Other specific mentions	935	14.8
$N = 6311$, multiple selection possible		

A gender-specific consideration of the degree of use makes it clear that more than two-thirds (68.9%) of male respondents use AI-based tools for their studies. Female and diverse students show percentages of around 60% (59.6% for female respondents and 62.2% for diverse students) (Table 9).

Concrete use of AI-based tools. The explicit (and open) query about concrete tools results in the following order (top 5 AI tools in studies):

1. ChatGPT
2. DeepL
3. DALL-E
4. Midjourney
5. BingAI

In percentage terms, almost half of the students (49%) state that they use or have used ChatGPT/GPT-4. Furthermore, approx. 12% of the respondents state that they use DeepL. About 4% of the respondents also mention DALL-E, about 3% Midjourney and about 2% Bing AI. All other tools mentioned are used by <1% of the students surveyed (Table 10).

Areas of use. The specific areas of application for which the students surveyed use AI-based tools are particularly in the area of clarifying questions of understanding and explaining subject-specific concepts. More than a third of all students surveyed (or 56.5% of students who use AI-based tools) use these tools for this purpose. Other very relevant usage functions are research and literature study (with 28.6%), translations (with 26.6%), text analysis, text processing, text creation (with 24.8%) as well as for

Table 11 "As part of my studies, I use AI for..." (multiple answers possible).

As part of my studies, I use AI...	Total sample ($N = 6311$)		People using AI in their studies ($N = 3970$)
	abs.	%	%
For research and literature studies	1803	28.6	45.4
For concept development, design	728	11.5	18.3
For data analysis, data visualisation, modelling	345	5.5	8.7
For problem solving, decision making	1395	22.1	35.1
For clarifying questions of understanding and having Subject-specific concepts explained to me	2245	35.6	56.5
For text analysis, text processing, text creation	1562	24.8	39.3
For translations	1676	26.6	42.2
For language processing	667	10.6	16.8
For exam preparation	805	12.8	20.3
For programming and simulations	594	9.4	15.0

Table 12 "Which aspects are/were most important to you in your assessment?" (Multiple selection possible).

Characteristics	abs.	%
Error prevention during output (e.g. hallucination)	3550	56.3
Degree of scientificity (e.g. citation)	4875	77.2
Logical reasoning (e.g. answers are comprehensible)	2942	46.6
Explainability of the decision (e.g. white box vs. black box)	2176	34.5
Error detection and correction during input (e.g. grammar)	1601	25.4
Price	2555	40.5

problem-solving, decision-making (with 22.1%) of all students (Table 11).

A detailed examination of the areas of application for the use of AI in studies in relation to the individual fields of study shows that in all fields (with the exception of art and art sciences as well as sport) the clarification of questions of understanding and explanation of subject-specific concepts has the highest proportion of use.

In *engineering*, the use of these tools for research and literature study (32%), translation (30.7%) and problem-solving and decision-making (30.3%) are the next highest.

The use of AI-based tools for research and literature study (24.3%), for translations (21.9%) as well as for text analysis, text processing, text creation (17.1%) shows the other high usage intensities in the field of study of *human medicine/health sciences*.

In the *humanities*, these tools are also used in particular for research and for studying literature (30.3%), for translation (28.6%) as well as for text analysis, text processing and text creation (25.4%).

Students in the field of *law, economics and social sciences* continue to show high usage values for research and literature study (28.3%), for translations (23.7%) and for text analysis, text processing and creation (22.8%).

Students from the field of *mathematics and natural sciences* also use AI-based tools for problem-solving, decision-making (27.5%), for translations (27.5%) and for research and literature study (27%).

In the field of study of *agricultural, forestry and food sciences as well as veterinary medicine*, the tools are also used for research and literature study (20%), for text analysis, text processing, text creation (18.8%) as well as for problem-solving and decision making (16.5%).

For students of *art and art sciences*, the four most relevant uses are text analysis, word processing, text creation (35.4%), clarification of understanding and explanation of subject-specific concepts (32.2%), translation (30.9%), and research and literature study (30.6%).

Sports students use AI-based tools especially for translations (40.6%) for text analysis, text processing, text creation (37.5%), for research and literature study (37.5%) as well as for exam preparation and (with the same intensity) for concept development & design (21.9% each).

Students in *other subjects* use AI-based tools to clarify comprehension questions and explain subject-specific concepts (32.3%), for translations (23.3%), for research and literature study (22.9%) as well as for text analysis, text processing and creation (19.7%).

It should also be emphasised that in the fields of *engineering* and *mathematics/science*, approximately a quarter of students each use AI-based tools for programming and simulations (27.2% in *engineering* and 24.2% in *mathematics/science*). Almost a third (30.2%) of students in the field of *art and art sciences* also use these tools for concept development and design.

Preferred characteristics of AI-based tools. In order to identify the most important characteristics of an AI-based tool from the students' point of view, in addition to the degree of use and the central areas of use, the students surveyed were given five possible characteristics. The percentage agreement values result in the following order of relevance: 1. degree of scientificity (e.g. citation). 2. avoidance of errors in output (e.g. hallucination) 3. logical argumentation (e.g. answers are comprehensible) 4. price 5. explainability of the decision (e.g. white-box vs. black-box) 6. error detection and correction during input (e.g. grammar) (Table 12).

A dedicated evaluation according to the study areas confirms in all study areas the relevance and order of scientificity as the most important criterion, error avoidance during output as well as logical argumentation as criteria directly following in relevance.

Critical reflection

In addition to the limitations of the methodology already mentioned in the section "Methodological approach", the procedure can be further critically reflected based on the quality criteria of quantitative research, objectivity, reliability, and validity.

Objectivity is assumed for the results. This is supported by the fact that the conduct of the survey is independent of the authorship due to the online survey and that the questionnaire is standardised.

It can be assumed that the results can be reproduced in a new survey with the same measurement instrument and an unchanged measurement object. This is supported by the fact that students from all subject groups were surveyed throughout Germany. For this reason, it is assumed that the results are reliable. However, it should be mentioned here that the distribution of students in the sample does not correspond exactly to the distribution in the population. A chi-square goodness-of-fit test shows that the observed frequencies in the distribution of fields of study deviate significantly from the expected frequencies based on the distribution in the population (χ^2 (8, $n = 6306$) = 2940.258, $p < 0.001$). The observed frequencies of the states also differ significantly from the expected frequencies (χ^2 (15, $n = 6307$) = 8485.039, $p < 0.001$). Likewise, significantly

more females (60.3%) than males (33.8%) participated in the survey. There is also a significant difference between the observed and expected frequencies (χ^2 (1, $n = 5939$) = 461.755, $p < 0.001$). No information can be given here on the number of diverse students, as no official statistics are available on this. The average age in the sample differs significantly from the average age of students in Germany, T (5479) = 10.390, $p < 0.001$, $d = 0.140$. According to Cohen, this is a weak effect.

The content validity of the survey was ensured by operationalising as completely as possible the abilities of language-based AI tools in the context of studies, using ChatGPT/GPT-4 as an example. Since there have been no comprehensive surveys to date that take into account all areas of study and the relevant application possibilities, it was decided to ask ChatGPT itself about its possible uses. From the responses of the AIs, an overview of the different possible uses emerged, divided into the various use categories. These were collected in the questionnaire in the context of the areas of use (ChatGPT, personal communication, 03. & 04.05.2023, see appendix).

Since no studies on concrete usage behaviour and relevant trait characteristics in the use of AI-based tools could be found on a national level so far, construct validity cannot be conclusively certified.

In summary, it can be said that although it is not completely possible to comply with the quality criteria in their entirety, this is due to the subject of the study. Since AI-based tools such as ChatGPT are a new development that has only become increasingly popular in recent months, there have only been limited studies on this subject of investigation so far. For this reason, the procedure for the present study was very explorative.

Conclusion and prospects

The study makes it clear that AI-based tools have found their way among students in all fields of study in Germany and are being used. Almost two-thirds of the respondents have used or are using such tools. In this context, the fields of engineering and mathematics and natural sciences show the highest intensity. In addition to the already described circumstance that the use of such tools could be actively demanded in the study programmes of these areas, further reasons for this high use could lie in a possible affinity for technology on the part of the students in these areas and/or—considering that the degrees of use show gender-specific differences—also in a possible higher proportion of male students in these study areas. If one considers the higher usage figures of such AI-based tools in the context of private use in this context, a possible, higher use of AI-based tools in the area of study & teaching can also be assumed here.

In this context, almost half of all students surveyed explicitly mention ChatGPT or GPT-4 as a tool they use. The diffusion of this tool among students is well-advanced. A differentiated examination of the usage behaviour according to the fields of study makes it clear that the students use AI-based tools in a variety of ways. In addition, the results show that the relevant characteristics that AI-based systems should ideally possess from the students' point of view are also of a different nature.

What needs to be further investigated in this context is the occurrence of the gap between the importance of scientificity on the one hand, which is named as the most relevant criterion by almost three-quarters of the students, and the importance of logical reasoning (e.g. answers are comprehensible) (~50%) and explainability of the decision (e.g. white box vs. black box) (~35%) on the other hand. The fact that error avoidance in the output (e.g. hallucination) is regarded as very relevant or not by about half of the students will also have to be investigated further.

This documentation is a purely descriptive presentation of the results. Therefore, future inferential statistical evaluations will follow in order to obtain further analyses and thus also more detailed insights into the use of AI-based tools in studying and teaching.

Data availability

The datasets generated during and/or analysed during the current study are available in the tudatalib-repository, https://doi.org/10.48328/tudatalib-1219.

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Competing interests
The authors declare no competing interests.

Ethical approval
All procedures performed in studies involving human participants were in accordance with the ethical standards of the institutional and/or national research committee and with the 1964 Helsinki Declaration and its later amendments or comparable ethical standards. Since the authors' university does not have its own ethics committee, the guideline for the ethics vote of the German Research Foundation (DFG—Deutsche Forschungsgemeinschaft) was followed. This guideline states that an ethics application must be submitted if at least one of the following points applies: (1) The study involves persons who require special protection ("vulnerable groups"), such as persons with limited capacity to consent. (2) The investigation and the material used in it are likely to trigger strong emotions, strong psychological stress or traumatic experiences in the participants (interviewees, informants, project staff, researchers and research subjects) that go beyond everyday experiences. (3) The research implies physical risks to participants or results in physical pain. (4) Potential participants should not be informed about the investigation. (5) Potential participants should not be informed about the potential risks of participation and measures to prevent harm. (6) Participation in the investigation implies deception (e.g., in laboratory experiments). (7) The study exposes participants (interviewees, informants, project collaborators, researchers, and research subjects) to special risks (such as social risks, risks of criminal or civil liability, financial losses, professional disadvantages or damage to reputation; risk due to the difficult security situation in the investigation area). Since none of these points apply, an ethics application is not necessary in this case.

Informed consent
Informed consent was obtained from all participants and/or their legal guardians.

Additional information
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