

Article

Usage, Benefits and Challenges of Generative Artificial Intelligence in Mathematics: The Student Perspective

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Abstract

The rapid influx of generative artificial intelligence (GenAI) into higher education has resulted in a large number of research studies over the past three years. Much of the research to date has focused on the researcher/educator perspective of the optimal usage, benefits and challenges in the implementation of GenAI, often in a very general sense. The importance of the student voice and discipline-specific results must not be lost in this debate. This study investigates students' decisions to use (or not use) GenAI for mathematics purposes and the reasons they give to support this choice. This was done by surveying almost 700 students in an Irish university, using an online, anonymous survey in March 2025. The students in the sample were all studying at least one mathematics module at the time. In addition, students were asked what they perceive the benefits and challenges to be of GenAI for mathematics in higher education. 91% of respondents were using GenAI for mathematics purposes. Both their reasons for using GenAI and the benefits they perceived for it fell into four main themes: Self-Improvement, Tools, Access, and Support. Their reasons for not using GenAI, and the challenges they perceived, were categorised under Unnecessary/Unknown, Inaccurate, Skill Loss, and Ethical Concerns. Students mentioned using GenAI for self-improvement reasons, such as bettering their understanding of mathematics, and found the lack of interaction with a person to be a benefit rather than a challenge. This study was conducted at a unique moment in time when the usage of GenAI was moving from sporadic to widespread and reflects students' self-reported reasons for this.

Keywords: benefits of GenAI; challenges of GenAI; ChatGPT; generative artificial intelligence; higher education; mathematics; student perspective



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1. Introduction

Mathematics occupies a pivotal role within higher education, not only as a discipline in its own right but also as a foundational component of programmes in science, engineering, computer science, business, social sciences, and education. Mathematical training remains a critical component, equipping students with the analytical, quantitative, and problem-solving skills required across this wide range of professions and disciplines. Throughout the history of mathematics education, technological tools have influenced how mathematics is taught and learned, from calculators and computer algebra systems to dynamic visualisation software. Free, online mathematics calculators have been available to students for many years; however, the capabilities of the likes of Wolfram Alpha (<https://www.wolframalpha.com/> (accessed on 19 July 2026)) were traditionally not fully exploited by students, with many never engaging with such resources (Ní Shé et al., 2017).

The advent of generative artificial intelligence (GenAI) into higher education in general has already had a transformative effect, despite tools such as ChatGPT only being launched in late 2022 (Wu et al., 2023). However, the usefulness or popularity of GenAI for mathematics purposes in higher education has not been extensively investigated to date. At the time of writing, no large-scale studies of usage of GenAI for mathematics in higher education have been published, and therefore this is an outstanding research question that needs to be addressed. Mathematics is a particular discipline unto itself, and the ability of GenAI to deal with logic and calculations has been of mixed accuracy and, as such, of mixed usefulness, although its capabilities are improving all the time. Large-language models (LLMs) that form the basis of tools such as ChatGPT are not designed explicitly for mathematical usage. However, it is now possible to exploit the capabilities of Wolfram Alpha directly through ChatGPT, greatly improving the accuracy of the content produced (Wolfram, 2023). What remains unclear at this point is whether students are choosing to engage with this capability for mathematics purposes.

In addition to knowing usage levels of GenAI for mathematics, it is of value to know the purpose that students ascribe to their usage, or their decision to not use GenAI for mathematics. Indeed, the question of the purpose for which students use GenAI for mathematics has been identified as one of the most urgent research questions to answer in relation to university mathematics (Iannone et al., 2025). It is also worth exploring what they perceive the benefits and challenges of GenAI usage for mathematics to be (also identified as a key research question (Iannone et al., 2025), albeit more so from the lecturer point-of-view). The inclusion of the student voice allows us to better understand their motivation and reasons for engaging with GenAI for mathematics. Therefore, the research questions we wish to address in this paper are:

RQ1: Why do students use/not use GenAI for mathematics?

RQ2: What do students perceive to be the benefits of GenAI usage for mathematics?

RQ3: What do students perceive to be the challenges of GenAI usage for mathematics?

In order to address these questions, we undertook a survey of almost 700 students at Dublin City University, Ireland, in March 2025. These students were all studying some type of mathematics module at the time, and answered a series of questions in relation to their usage and perspectives of GenAI in relation to mathematics. Insights gleaned from this study will allow educators to better focus their time and efforts in helping students to deepen their understanding of mathematics, and to consider how best to ensure that students who are using GenAI for mathematics are doing so in a manner that benefits their education.

2. Literature Review

Much of the research published to date on the benefits and challenges of GenAI is from the educator's point of view, some in terms of general education (Hoernig et al., 2024; Kurtz et al., 2024; Mulaudzi & Hamilton, 2025; Rasul et al., 2023), and some specific to mathematics education (Busuttil & Calleja, 2025; Egara & Mosimege, 2024; Rane, 2023; Walkington, 2025). We will review a selection of these now, before focusing more specifically on student perspectives.

2.1. Researcher/Educator Perceptions of GenAI in Education

A report produced by the Institute of Public Policy in Lisbon breaks down the benefits and risks of GenAI in education into categories relevant to educators, students, and educational institutions, to show "how the risks of GenAI in higher education can be managed while harnessing its potential" (Hoernig et al., 2024, p. 40). The benefits they identified for students include advanced study support; enhanced self-learning management; en-

hanced research skills; and a boost to asynchronous education and student self-motivation. Meanwhile, the risks for students include lack of critical thinking and creativity; stimulus overload and dependence; increased individualisation and reduced social skills; hallucinations and reinforcement of biases. A team of researchers in Israel came together to formulate the benefits and challenges they perceive of GenAI in higher education and provide recommendations for its usage (Kurtz et al., 2024). Their observations largely overlap with those mentioned above, although they also highlight concerns about privacy and ethical usage. A South African study explored the opinions of 16 lecturers in relation to GenAI (Mulaudzi & Hamilton, 2025). In this case, several lecturers revealed their initial unease and negativity towards GenAI, while admitting they saw it as “unavoidable” and voiced some “cautious optimism” towards the potential impact it could have in education. When asked for benefits and concerns, these again largely aligned with those previously mentioned. A team of researchers based in Australia, Brazil and India came together to examine the benefits and challenges of ChatGPT specifically, again in relation to the higher education landscape (Rasul et al., 2023). They identified five benefits to ChatGPT: the potential to facilitate adaptive learning; provide personalised feedback; support research and data analysis; offer automated administrative services; and aid in developing innovative assessments. They also identified five challenges: academic integrity concerns; reliability issues; inability to evaluate and reinforce graduate skill sets; limitations in assessing learning outcomes; and potential biases and falsified information in information processing. It is clear that many of these benefits and challenges listed in this wide range of studies are given from an educator rather than a student perspective.

2.2. Researcher/Educator Perceptions of GenAI in Mathematics

An autoethnographic study related to the use of artificial intelligence in mathematics education identified 11 benefits, 12 challenges and five ethical considerations (Opesemowo & Ndlovu, 2024). While the authors did not focus solely on GenAI, many of the items they identified are relevant. The benefits they listed relevant to students were personalised instruction; adaptive assessment; interactive learning environments; real-time feedback; reinforcement learning for mathematics tutoring; and ChatGPT. The relevant challenges were lack of creativity and problem-solving skills; inability to explain reasoning; overemphasis on computational skills; bias in data and algorithms; lack of emotional intelligence; data privacy and security concerns; dependency on AI for problem-solving; lack of real-time interaction; oversimplification of concepts; inequitable access; loss of critical thinking ability. The ethical considerations were data privacy and security; algorithmic bias and fairness; inclusive access and digital divide; collaboration; public engagement and participation. Many of these would be unlikely to be identified by students using the technology, indicating the different focus of researchers or educators when considering this issue, and the importance of considering the student voice.

The timing of these early studies appears to have quite an impact on their findings. For example, a study of 80 mathematics teachers in Nigeria in 2023 found that their awareness and experience of ChatGPT was low (Egara & Mosimege, 2024). As a result, their perceptions of the challenges of ChatGPT were high, and many of these challenges are no longer as relevant as more advanced versions of ChatGPT have been released that can better handle mathematics. In a slightly later study of 109 mathematics and science teachers in Abu Dhabi, UAE, a survey investigated their usage and perceptions of ChatGPT in the classroom (Taani & Alabidi, 2024). The authors state that they chose science and mathematics in order to investigate non-language-based performance of ChatGPT in the classroom. Teachers were broadly positive about ChatGPT, finding it encouraged creativity, critical thinking and gave students instant feedback. It also allowed teachers to

analyse student responses and interactions to address weaknesses, allowing for targeted interventions within the classroom.

A case study of 30 early adopters of ChatGPT in mathematics education found that they identified both benefits and risks to its use in mathematics education (Wardat et al., 2023). Among the benefits listed were its ability to improve students' mathematical capabilities and enhance their learning experience. Risks included inaccuracies in the mathematical content, a potential overreliance on technology, and loss of human interaction in the learning process, echoing what was found in other studies mentioned above.

In Malta, 107 secondary-school teachers took part in an investigation into their opinions and intended usage of ChatGPT in the mathematics classroom (Busuttil & Calleja, 2025). It was found that their intended usage related to their beliefs of mathematics teaching and learning. Those whose beliefs aligned more with discovery and connectionist beliefs were interested in creating problem sets or assessments with ChatGPT, while those with transmission beliefs favoured the use of ChatGPT for transmission of information by giving explanations or examples. However, the beliefs of their students did not feature in this study.

2.3. Student Perceptions of GenAI in Higher Education

A scoping review of the literature in relation to student perceptions of GenAI in higher education showed that these studies are most often conducted in STEM disciplines (Schei et al., 2024). Many studies to date have focused either on general usage of GenAI tools, or on a particular implementation within a class group which has then been analysed. As a result, some regional or cultural differences can be expected between studies, although there are strong overriding themes that continue to emerge. For example, a study of 277 Ghanaian higher education students in relation to their perspectives on ChatGPT found that, while students are aware of and recognise the potential of GenAI tools, they predominantly use them for non-academic purposes, due to concerns about academic violations and overreliance on technology (Baidoo-Anu et al., 2024). Similar concerns about over-reliance on GenAI were expressed in a survey of 375 students from the United Arab Emirates, while these students were also concerned about their critical thinking skills being adversely affected (Farhi et al., 2023). A slightly later survey of 200 undergraduate students in Malaysia, mostly from Computer Science, showed that 29% feared that they could definitely become over-reliant on GenAI, with a further 36% thinking that this was a possibility (Ahmed et al., 2024).

A mixed-methods study of 16 interviews and 124 surveys with Business students in Denmark found that students greatly valued the automation and immediate productivity outcomes of the technology (Razmerita et al., 2025). Similarly, a survey of 737 university students in the Balearic Islands found that students felt that the benefits of ChatGPT outweighed the risks, and particularly praised the 24/7 nature of the support they could receive from GenAI and the efficiencies it could generate, while also expressing concerns about possible over-reliance on the technology (Blahopoulou & Ortiz-Bonnin, 2025). In-depth interviews with 15 social care students in the United States found that five main themes emerged: namely increased efficiency, ethical considerations, risk concerns, psychological impacts, and societal impacts (Kapur et al., 2026).

2.4. Student Perceptions of GenAI in Mathematics

There is a dearth of research currently into the student perspective and experience of using GenAI for mathematical purposes. Although Haddley and Ardito (2024) undertook their case study with three mathematics students in the U.K., to ascertain their experiences of using GenAI, they did so in relation to an additional skills module which involved essay-

writing, meaning that the findings are more typical of general studies than of mathematics. While using GenAI in the module, students raised concerns about academic integrity and equity issues in relation to access to paid versions of GenAI. They reported benefits in terms of brainstorming, structuring their work, receiving feedback, summarising, and enhancing what they had written. Similarly, Divjak et al. (2026) surveyed students in Croatia who used a GenAI chatbot to solve a task and subsequently write a mathematical essay, with students tending to prefer to use GenAI for more theoretical than practical tasks within this assignment.

In a recent study in China, Zhou et al. (2025) explored the student perspective of utilising GenAI for problem-solving during a combinatorics module aimed at those intending to be mathematics teachers. In interviews with 10 students, they found that students valued the personalised support that ChatGPT could provide that was specific to what they themselves needed. They also found that it could provide scaffolded prompts rather than providing them with the full answer, which was helpful for their learning. A similarly small-scale study in Israel, conducted with pre-service teachers, found that the majority of students felt that the use of GenAI had improved their exam results in mathematics (Slobodsky & Durcheva, 2025). A survey of 36 STEM students undertaking a remedial mathematics module in the United States, in which students were instructed to engage with ChatGPT in relation to the mathematical content of their module, found that more than half of them found the generated material to be accurate in pointing out errors, and that many students chose to solve the problems themselves as well in order to verify the content provided (Joung & Kim, 2026). A small-scale study of 30 mathematics education students studying linear algebra in Indonesia found that almost 95% of respondents felt that the use of technology such as ChatGPT in mathematics education helped students to understand better, although the authors felt that this was only true for low-difficulty problems (Fardian et al., 2025). However, all of these studies are small-scale and mostly in relation to a specific mathematics module or intervention, rather than giving a more general insight into students' perspectives on GenAI usage in mathematics.

2.5. Conceptual Framework

The literature reviewed above highlights that students' engagement with GenAI in mathematics is multifaceted and cannot be understood solely in terms of adoption of the technology or frequency of use. Thus, this study is informed by a conceptual framework consisting of three interconnected dimensions: reasons for use or non-use, perceived benefits, and perceived challenges, as shown in Figure 1. The first dimension recognises that students make deliberate decisions about whether and how to engage with GenAI when studying mathematics in higher education. The second dimension captures the ways in which students perceive GenAI as being of benefit generally when studying mathematics. The third dimension encompasses the challenges and risks students associate with GenAI use for mathematics. These dimensions are viewed as interrelated, with students' perceptions of benefits and challenges shaping their decisions to use GenAI, while their experiences of use may in turn influence subsequent perceptions. The framework therefore provides a coherent structure for investigating students' experiences and for interpreting both quantitative and qualitative data collected in the study.

Student Engagement with GenAI in Mathematics: A Conceptual Framework

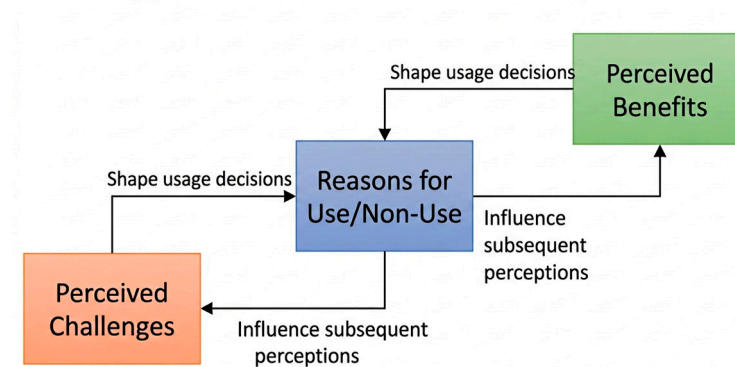


Figure 1. Diagram showing the ways in which the dimensions of the framework are interrelated in our conceptual framework for Student Engagement with GenAI in Mathematics.

3. Materials and Methods

3.1. Survey Instrument

The survey used in this study was purpose-designed, as we had found no similar surveys in the literature at the time. It was piloted with a group of postgraduate mathematics students, and changes were subsequently made to the question wording for greater clarity. The opening questions on the survey are profiling questions regarding gender, degree programme, year, and mathematical confidence. There were then separate sections in the survey dealing with usage of mathematics support, usage of generative AI for mathematics, and usage of generative AI more generally. In this paper, we will be focusing on the middle section, which looked at usage of generative AI for mathematics. In particular, we will be focusing on the four open-ended questions dealing with usage and perception of generative AI for mathematics. Further details on other sections can be found in [Feeney and Ní Fhloinn \(2026\)](#).

3.2. Data Collection

The survey was conducted online using Google Forms. One of the authors attended mathematics lectures and explained the study being undertaken before offering students the option to complete the survey online at that time. In addition, students had the option of taking a printed copy of the survey to complete, but nobody chose that option. After visiting the lecture in person, an email was then sent to students with a link to the survey, to offer those who had not been present in the lecture (or who had changed their minds and wanted to participate) the opportunity to complete the survey in their own time.

3.3. Data Analysis

Overall, the quantitative data were analysed using Google Sheets and SPSS version 30.0. The quantitative data reported in this paper only required simple analysis to report the count in various profiling questions or binary closed-response questions, and as such, only Google Sheets was used here. There was no transcription required for the qualitative data as all responses were given online by respondents into the Google Forms survey. The qualitative responses were analysed using a general inductive approach. While the study was informed by a conceptual framework comprising reasons for use or non-use, perceived benefits, and perceived challenges of GenAI in mathematics, coding was conducted inductively to allow themes to emerge from the data. Thus, the qualitative data were coded using General Inductive Analysis ([Thomas, 2006](#)), in which the two authors read and re-read the responses independently several times before clarifying what broad themes and/or sub-themes were emerging under each question, with specific text segments

assigned particular labels to create initial codes. A second pass through the data was done to refine the codings and collapse many of the similar labels, resulting in a number of overarching themes with subthemes under each. At this point, the researchers shared their codings with each other and completed a third pass through the data together to agree the final themes and subthemes. The initial inter-coder reliability for the coding of qualitative responses was 89%, with all final themes and subthemes agreed by both. A single response may be coded under more than one theme, depending on the content, as some responses to open-ended questions were quite long and addressed a number of points. As such, “respondents” in the text refers to the number of individuals who commented, while “counts” or “instances” refers to the number of times a theme/subtheme emerged in open-ended responses. Inductive coding was used in this instance as the usage of GenAI for mathematics was still a very new area and, as such, taking an inductive approach allowed us to focus specifically on what was in the data rather than attempt to presuppose what themes might emerge.

3.4. Sample

The responses to the profiling questions asked at the start of the survey can be seen in Table 1 below. Some of the groupings (e.g., Psychology/Economics) are based on the common mathematics modules these students would take within the university. The total number of respondents (691) represents 39.6% of possible respondents from this cohort (students taking a mathematics module in this university).

Table 1. Responses to the profiling questions asked in the survey ($n = 691$).

		Number	%
Gender	Male	382	55.3%
	Female	286	41.4%
	Non-binary/Trans/Queer	6	0.9%
	Blank	17	2.5%
Year of Study	1st	383	55.4%
	2nd	250	36.2%
	3rd	20	2.9%
	4th	34	4.9%
	Other (Visiting students)	4	0.6%
Discipline of Study	Science	233	33.7%
	Engineering	145	21.0%
	Mathematics	115	16.6%
	Mathematics Education	84	12.2%
	Computer Science	70	10.1%
	Accounting	30	4.3%
	Psychology/Economics	8	1.2%
	Blank	6	0.9%

3.5. Limitations

Almost all respondents completed the survey during lectures, with only a handful completing the survey in their own time. As such, the results may not be representative of the entire student population and may be biased towards those who attend lectures, or indeed towards those with stronger feelings towards GenAI, both positive and negative.

In addition, only students who were studying mathematics modules from a single Irish university were included in the sample, meaning that the results may be localised to that context and there may be a disciplinary imbalance within the sample. All the responses are based on self-reported data, many from open-ended questions, and as such could be prone to bias. In addition, there have been many developments in GenAI since March 2025, when the survey was undertaken, so the results may no longer be representative, but more so offer a snapshot in time on GenAI usage.

4. Results

Full results regarding usage statistics, frequency of use, tools chosen, and differences between mathematics and non-mathematics usage statistics can be found in [Feeney and Ní Fhloinn \(2026\)](#). For the purposes of this paper, it is sufficient to report that 91% of the 691 respondents reported using GenAI for mathematics, while 89% reported using GenAI for non-mathematics queries. ChatGPT was by far the most common GenAI tool used by students for both mathematics and non-mathematics purposes, with over 90% of respondents using this tool. Over a third of users of GenAI for mathematical purposes had used it for the first time in the three months preceding the survey.

4.1. Why Do Students Use GenAI for Mathematics?

Respondents who indicated that they had used GenAI at any point for mathematics were then asked “For what purpose do you use GenAI tools for maths?”. There were 623 responses to this question, which were coded under four main themes: self-improvement, tools, access and support. Each of these four themes had a number of sub-themes, as shown in Figure 2.

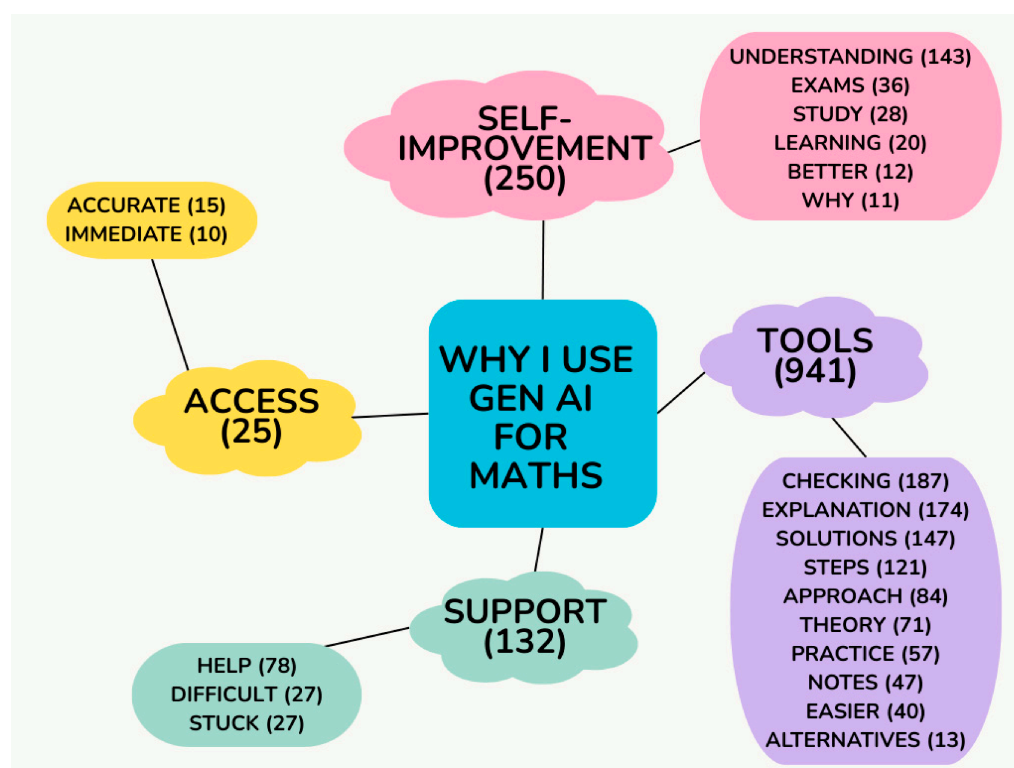


Figure 2. The themes and sub-themes identified in the 623 responses to the question “For what purpose do you use GenAI tools for maths?”. The numbers in brackets indicate the number of instances of each theme or sub-theme under this question.

The prevalence of each of these sub-themes is indicated in Table 2, along with some sample comments, to give greater clarity as to what is meant by each theme or sub-theme.

Table 2. The number of instances of each sub-theme in response to the question “For what purpose do you use GenAI tools for maths?”.

Theme	Subtheme	#	Sample Comments
Self-Improvement	Understanding	143	“Getting more of a background understanding of the topic itself”
	Exams	36	“getting it to ask me exam style questions”
	Study	28	“study help”
	Learning	20	“learning material, learning different methods”
	Better	12	“to understand the topic better”
	Why	11	“how to understand why it is done this way”
Tools	Checking	187	“checking if my answers are correct when doing exam style qs when studying”
	Explanation	174	“Explain when to use certain equations using examples, explain how to answer certain questions”
	Solutions	147	“For solutions when they are not provided(most of the time)”
	Steps	121	“To see problems broken down into easy simple steps”
	Approach	84	“I’ll use it to start a problem for me if I’ve already tried it multiple time by myself”
	Theory	71	“deeper understandings of theory”
	Practice	57	“creating sample questions mostly where I can do questions like the ones I’m struggling with”
	Notes	47	“reword and rephrase notes”
	Easier	40	“I use it to translate complicated lecture notes and materials into more understandable language”
Access	Alternatives	13	“find other methods to get to answers”
	Accurate	15	“A quick explanation however I am aware this is not always 100% accurate hence why I would also use the MLC” (Maths Learning Centre)
	Immediate	10	“to get the formula required immediately”
Support	Help	78	“to help get answers”
	Difficult	27	“Guidance in difficult maths Qs”
	Stuck	27	“assignments or material I’m stuck on”

4.2. Why Do Students Not Use GenAI for Mathematics?

There were 61 comments made by respondents in relation to the question “Why do you not use GenAI tools for maths?”. These were coded into four main themes: Unnecessary/Unknown, Inaccurate, Skill Loss, and Ethical Concerns. Each of these had at least one sub-theme, as shown in Figure 3 below.

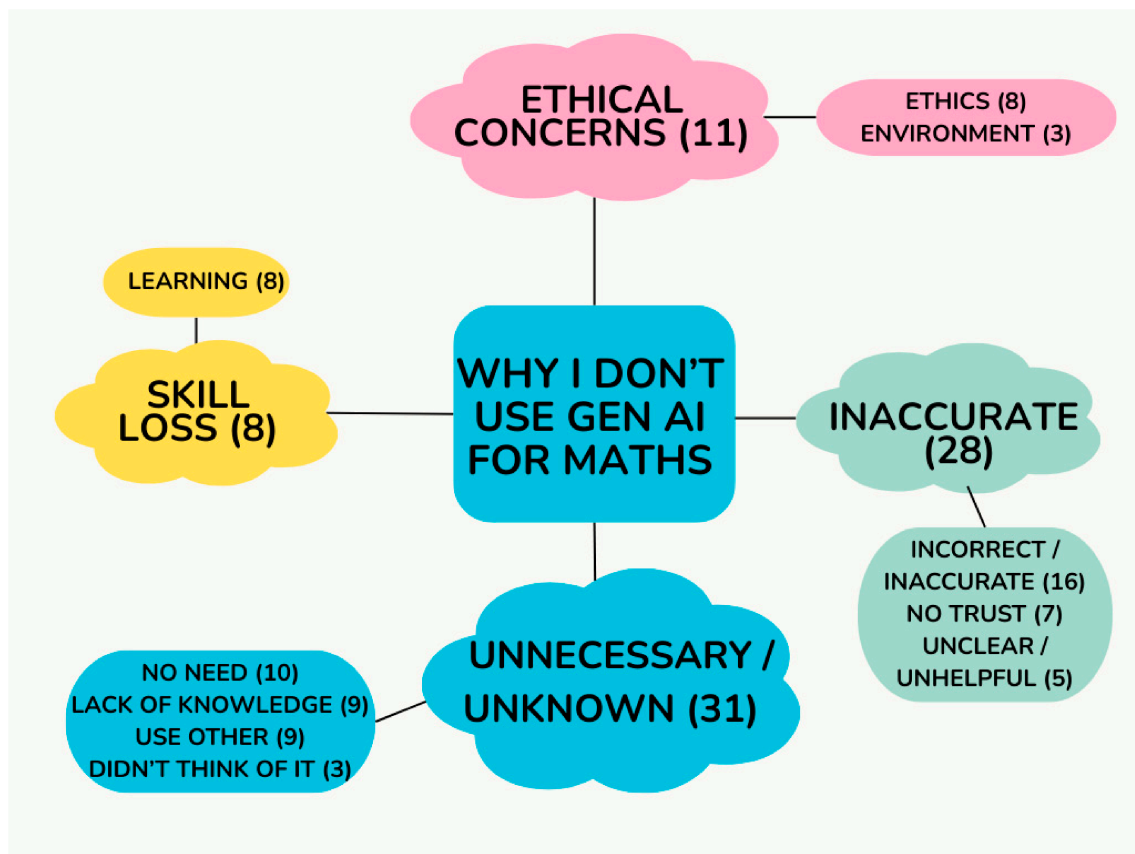


Figure 3. The themes and sub-themes identified in the 61 responses to the question “Why do you not use GenAI tools for maths?”. The numbers in brackets indicate the number of instances of each theme or sub-theme under this question.

The prevalence of each of these sub-themes is indicated in Table 3, along with some sample comments.

Table 3. The number of instances of each sub-theme in response to the question “Why do you not use GenAI tools for maths?”.

Theme	Subtheme	#	Sample Comments
Ethical Concerns	Ethics	8	“I don’t like generative AI. It . . . is notorious for stealing from people by scraping their content for the GenAi databases”
	Environment	3	“it is massively damaging to the environment”
Skill Loss	Learning	8	“hinders the learning process”
Inaccurate	Incorrect/Inaccurate	16	“Generative AI is often confidently wrong”
	No Trust	7	“Wouldn’t trust it fully, rather use my own understanding even if it’s wrong”
	Unclear/Unhelpful	5	“AI is often wrong or unclear in maths operations leading to more confusion”
Unnecessary/Unknown	No Need	10	“I am confident in my own abilities, and understand the material taught well enough to not need to use it”
	Lack of Knowledge	9	“I don’t know how to use them properly”
	Use Other	9	“I can get sufficient help from other sources like YouTube, Google or the MLC tutors”
	Didn’t Think of It	3	“Not something I ever thought of”

4.3. What Do Students Perceive to Be the Benefits of GenAI Usage for Mathematics?

There were 635 comments made by respondents in answer to the question “What do you think are the potential benefits of the use of GenAI in maths in Higher Education?”. These comments were coded into five main themes: self-improvement, tools, access, support and anonymity. Again, each theme is subdivided into a number of sub-themes, shown in Figure 4 below.

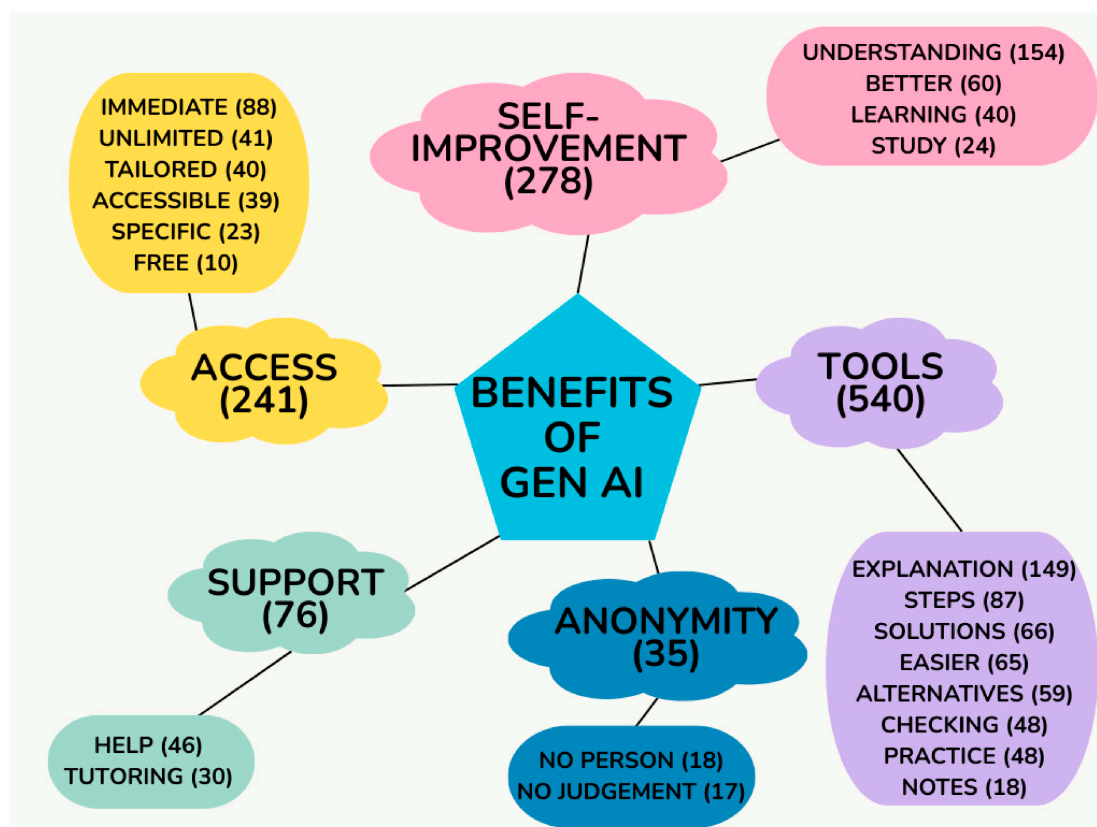


Figure 4. The themes and sub-themes identified in the 635 responses to the question “What do you think are the potential benefits of the use of GenAI in maths in Higher Education?”. The numbers in brackets indicate the number of instances of each theme or sub-theme under this question.

The prevalence of each of these sub-themes is indicated in Table 4, along with some sample comments.

Table 4. The number of instances of each sub-theme in response to the question “What do you think are the potential benefits of the use of GenAI in maths in Higher Education?”.

Theme	Subtheme	#	Sample Comments
Self-Improvement	Understanding	154	“Can help advance students understanding of topics”
	Better	60	“To gain a better understanding on certain topics.”
	Learning	40	“Learning at a personal pace”
	Study	24	“I think it’s helpful for reviewing material you already know.”

Table 4. *Cont.*

Theme	Subtheme	#	Sample Comments
Tools	Explanation	149	"Can explain certain topics easily with examples."
	Steps	87	"Allows questions to be broken down step by step which professors may not have time for"
	Solutions	66	"It can provide solutions with clear paths as to how it got the answer"
	Easier	65	"Make it easier to help understand difficult questions"
	Alternatives	59	"able to explain concepts and ideas in a variety of different ways"
	Checking	48	"Checking answers I got are correct"
	Practice	48	"Useful to generate more questions since there can be a very limited number of questions to practice before an exam"
	Notes	18	"Easily reword notes"
Access	Immediate	88	"Allows students to get a quick answer"
	Unlimited	41	"It can provide in-depth knowledge because you can ask as many questions as you want"
	Tailored	40	"Give students the opportunity to tailor maths learning to their specific needs"
	Accessible	39	"Easier access to information"
	Specific	23	"You can ask it questions about very specific parts of a question"
	Free	10	"provide help for those who cannot afford it"
Support	Help	46	"Can be great help for anyone who doesn't have help outside of a class"
	Tutoring	30	"Acts as a computerised tutor"
Anonymity	No person	18	"You can get taught maths without the need of a person teaching you, not taking up anyone's time"
	No judgement	17	"A lot of ppl feel dumb going up to someone and asking to like fully simplify problems like even the smallest details cab be asked with Gen Ai no judgement or exasperation"

4.4. What Do Students Perceive to Be the Concerns of GenAI Usage for Mathematics?

There were 645 responses to the question "What do you think are the potential concerns about the use of GenAI in maths in Higher Education?", and these were coded into three main themes: Inaccurate, Ethical Concerns, and Skill Loss. The former of these had no sub-themes, but the other two did, as shown in Figure 5 below.

The prevalence of each of these sub-themes is indicated in Table 5, along with some sample comments.

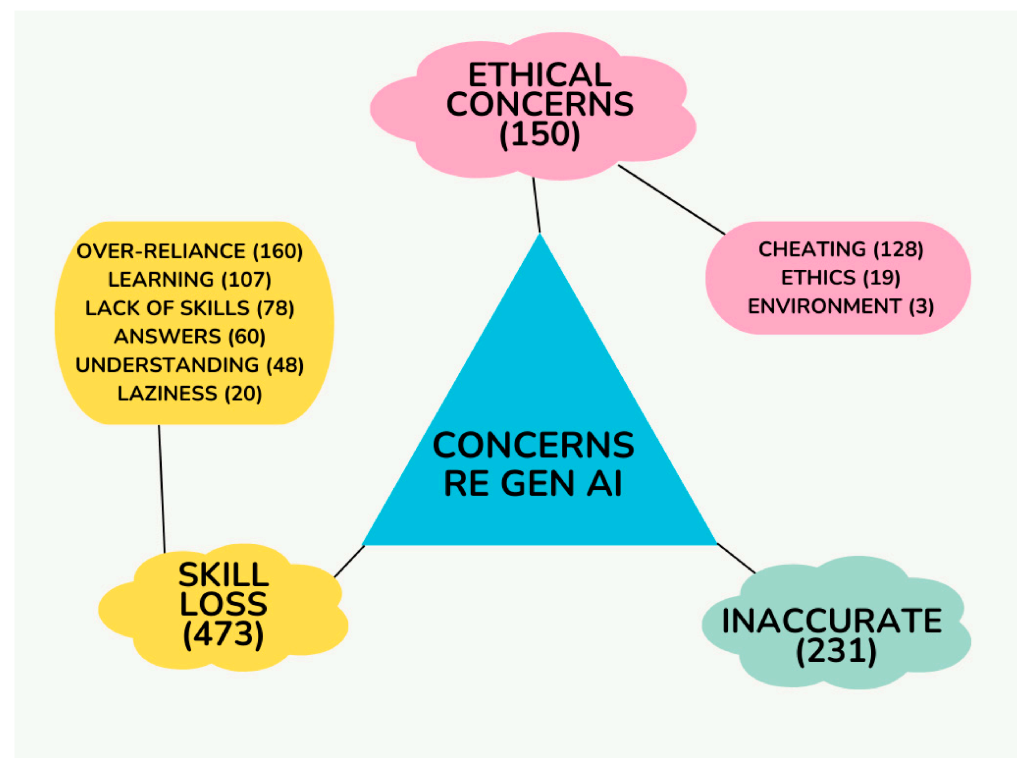


Figure 5. The themes and sub-themes identified in the 645 responses to the question “What do you think are the potential concerns about the use of GenAI in maths in Higher Education?”. The numbers in brackets indicate the number of instances of each theme or sub-theme under this question.

Table 5. The number of instances of each sub-theme in response to the question “What do you think are the potential concerns about the use of GenAI in maths in Higher Education?”.

Theme	Subtheme	#	Sample Comments
Ethical Concerns	Cheating	128	“Cheating in homeworks and online tests”
	Ethics	19	“Academic integrity”
	Environment	3	“bad for the environment”
Skill Loss	Over-reliance	160	“People may use it to much and become reliant on it.”
	Learning	107	“People will no longer learn themselves how to solve given problems”
	Lack of skills	78	“Reduces mental maths and problem solving skills”
	Answers	60	“People using it to answer questions before trying to attempt themselves”
	Understanding	48	“If you use it to just do your homework without understanding it or trying to do it yourself first.”
	Laziness	20	“Could make people less willing to do the work themselves”
Inaccurate	Inaccurate	231	“Answers from gen ai can be wrong a lot of the time”

5. Discussion

Having reported the results in relation to each individual question above, we now consider our data through the lens of the three-dimensional conceptual framework presented earlier in the paper. The results in the previous section show that when higher education students discuss GenAI for mathematics, there exists an interplay between the reasons

given for use/non-use, perceived benefits and perceived challenges. We now consider how students' experiences shape and alter their ongoing perceptions of these tools. Some of what has emerged may be regarded as unique to mathematics as a discipline, while other findings may also be extendable to other disciplines.

5.1. *Interplay Between Usage/Non-Usage and Benefits*

A core tenet of our conceptual framework is that students make deliberate choices about whether and how to integrate GenAI into their mathematical studies. This “intentional adoption” is heavily driven by how they perceive its immediate benefits. Rather than passively using GenAI, students actively use it to manage their own learning, seeking ways in which to improve their understanding and get tailored mathematical support.

5.1.1. Changes in Methods of Mathematical Verification

Our data show a large emphasis on “Checking” and “Solutions” (187 and 147 instances respectively under reasons for use, and 48 and 66 under benefits) within the Tools theme (941 instances). This reveals a major shift in how students verify their mathematical work. In a subject like mathematics, where there is a single correct answer for a specific question, students would long have been able to use a computational knowledge engine to check their answers, with Wolfram Alpha (Wolfram, 2010), launched in 2009, among the most popular choices for this. However, as mentioned earlier, research prior to the advent of GenAI showed low take-up of tools such as Wolfram Alpha among students (Anastasakis & Lerman, 2022; Ní Shé et al., 2017). The numbers in our study using GenAI for this purpose were striking in comparison.

When we look at this through our conceptual framework, this rapid adoption of GenAI is not just about its technical capacity to solve equations. It is driven by the perceived benefits of Access—specifically how it is “Immediate” and “Unlimited”—which make it easier to seek help. GenAI has also transformed the technology-based answer-checking process in mathematics from a more rigid, syntax-heavy query into a conversational interaction, in which the system offers further suggestions of help after supplying the initial check. ChatGPT has been found to provide the same level of detail, whether specifically asked “Please explain” when faced with a mathematical problem to calculate, as when simply given the problem (Pardos & Bhandari, 2024), so explanations are readily available to students once they enter their query, adding to the ease of use. Both this ease and ubiquity of acceptance appear to have impacted student behaviour in this regard.

However, this ease of access creates a tension within the “reasons for use” dimension. While many students use GenAI to check work they have already attempted, others who stated they were using it for solutions openly admitted to using it to bypass the problem-solving process entirely when they are short on time. This ties in with concerns expressed by educators that some students might “outsource their cognitive effort to machines” (Gogh & Kovari, 2025).

5.1.2. Desire for Mathematical Self-Improvement

A striking finding is the alignment between students' reasons for use and their desire for Self-Improvement (278 instances under benefits and 250 under reasons for use), particularly regarding “Understanding” (154 instances under benefits and 143 under reasons for use). Students heavily favour the “Explanation”, “Steps”, and “Approach” sub-themes under the Tools theme in relation to reasons for use, and the first two of these in relation to benefits. This shows that they prize GenAI's ability to break down complex problems into step-by-step, scaffolded, tailored learning paths. This step-by-step approach valued by students is one that is quite natural to a GenAI tool like ChatGPT, and the “scaffolded prompts” it can generate also appeared as a benefit in (Zhou et al., 2025).

Combining these subthemes shows that students are not simply looking for a “magic box” to spit out answers; they are looking for a personalised learning tool. This aligns with Hoernig et al.’s (2024) predictions regarding “enhanced self-learning management.” It also mirrors Fardian et al.’s (2025) findings that interactive GenAI prompts can positively impact conceptual understanding in linear algebra. Students are using GenAI to generate alternative explanations and custom practice questions to actively fill the gaps they perceive in their university course materials. This demonstrates a highly sophisticated, self-regulated approach to learning mathematics. Students in this sample who approached GenAI in this way did so without this idea being explicitly suggested to them by a lecturer, as this had not been undertaken by any of the lecturing staff in the university at this time, although this has been attempted by numerous educators in recent years (Manik et al., 2024; Pardos & Bhandari, 2024; Zein et al., 2024).

5.1.3. Access and Anonymity

When comparing why students use GenAI versus what they see as its general benefits, a key shift happens around the theme of Access. Perceptions of access-related benefits skyrocketed from 25 instances (in their own reasons for use) to 241 instances (as a general benefit). Students place immense value on GenAI being “Immediate”, “Unlimited”, “Tailored”, and “Free”. This immediacy of response was also identified in Razmerita et al. (2025), although it was expressed as “time-saving” by Business students speaking about efficiencies in reading and writing. In mathematics, getting “stuck” at one point means you cannot proceed; getting “immediate” help at this point is important to students.

This idea of personalised mathematics support is one of the factors that has made mathematics learning support (MLS) centres so popular in many universities in Ireland and the UK, as well as further afield—with the obvious difference that MLS centres tend to rely on in-person supports as their main approach (Deacon & Ní Fhloinn, 2025), with some branching out to online support, particularly during and since the COVID-19 pandemic (Mullen et al., 2025). However, our framework reveals that GenAI fulfils a unique role that traditional MLS centres cannot match: it provides immediate, 24/7 support at the exact moment a student gets stuck at home.

Furthermore, the emergence of Anonymity (“No Person” and “No Judgement”) as a distinct perceived benefit highlights a major psychological factor in student adoption. In large university cohorts with limited face-to-face hours, students often fear being judged for asking “silly” questions. This, combined with diverse timetables and sometimes erratic study hours due to commuting or working, may mean that the need to have another person present to help you with study is difficult or sometimes impossible. GenAI acts as a non-judgmental personal tutor, matching the experiences of students in other disciplines, such as academic writing (Sevnarayan, 2024). Many of the comments under this theme reveal traits consistent with mathematical anxiety (Bessant, 1995; Wahid et al., 2014), suggesting that GenAI usage may offer one approach to easing this for students.

Importantly, while educators often view this lack of real-time human interaction as a pedagogical risk (Walkington, 2025) or an isolating factor (Hoernig et al., 2024), students explicitly reframe this isolation as a psychological benefit. There remains a dichotomy, however, in the fact that while students highly prize this unlimited availability and anonymity, they do not cite it as a strong reason why they themselves use GenAI, but frame it as a general benefit.

5.2. Tension Between Usage and Perceived Challenges

The third dimension of our framework focuses on the challenges and risks students associate with GenAI. Our conceptual framework suggests a sort of feedback loop: experi-

ences with these challenges should theoretically discourage students from using the tool if these challenges are severe enough. However, our findings instead reveal a fascinating paradox. While a large number of students (645 responses) identified significant challenges, 98.9% of these continued to use GenAI anyway. The perceived benefits of immediacy and support clearly outweighed the perceived risks of inaccuracy and skill loss for these students, a fact that has also been identified in other studies on GenAI in higher education (Abdaljaleel et al., 2024; Jo, 2024; Strzelecki, 2024).

5.2.1. Mathematical Inaccuracy

The most prominent individual sub-theme identified as a challenge by students was Inaccuracy (231 instances), with respondents highlighting errors in logical reasoning, incorrect calculations, misleading assumptions, and false mathematical notation. This issue has been observed in many research studies over the past couple of years (Frieder et al., 2023; Hamel, 2024; Memiş, 2025; Slobodsky & Durcheva, 2025; Wardat et al., 2023). Interestingly, this exact concern was the primary reason given by the 9% of non-users for avoiding the tool entirely. For non-users, this perception of unreliability was formed without direct experience, likely shaped by external academic warnings or experiences with GenAI in other subjects. This shows that pre-existing perceptions of risk can completely block adoption.

For active users, however, encountering these errors did not stop them from using the tool. Instead, it altered how they used it. Experiencing these errors forced students to evaluate the outputs critically, often requiring them to solve the problem themselves to “sense-check” the AI’s work, as was also found in Joung and Kim (2026). Thus, the challenge of inaccuracy inadvertently fosters a critical, evaluative engagement with the mathematics involved, transforming a flawed tool into an opportunity for deeper analysis.

5.2.2. Over-Reliance and Skill Loss

The single largest concern among students was Skill Loss (473 instances) via over-reliance (160 instances). Students openly worried that using GenAI would stop them from developing core mathematical competencies, such as critical thinking, independent reasoning, and foundational problem-solving. This fear directly mirrors concerns raised both in relation to general education by educators (Hoernig et al., 2024; Kurtz et al., 2024; Opesemowo & Ndlovu, 2024) and students (Baidoo-Anu et al., 2024; Farhi et al., 2023), and more specifically in relation to mathematics by educators (Egara & Mosimege, 2024; Sánchez-Ruiz et al., 2023) and students (Chan & Hu, 2023; Serhan & Welcome, 2024) in higher education.

This creates a clear cognitive dissonance for the student. Within our framework’s loop, students recognise that relying on GenAI for immediate solutions (Benefit) threatens their long-term mathematical mastery (Challenge). This tension shows that students are acutely aware of the thin line between using GenAI as a learning scaffold versus using it as a cognitive crutch.

5.2.3. Ethical Blindspots and Divergent Perspectives

Finally, the sub-theme of Cheating (128 instances) highlights a major ethical concern regarding continuous assessment, take-home exams, and online homework, although the instances of this were lower than might have been expected. Students expressed frustration over the unfairness of peers obtaining unearned grades by submitting unverified GenAI work without getting caught. While the ability to outsource mathematics assignments has existed for years via tools like Wolfram Alpha and others (Larkins & Seaton, 2024), GenAI’s conversational ease and widespread usage have normalised this behaviour on a much larger scale.

What is most revealing, however, are the challenges that students did not mention. Academic literature frequently warns about risks like equity issues, privacy and security concerns, reinforcement of biases, environmental impact, and reduced social skills (Buele et al., 2025; Haddley & Ardito, 2024; Hoernig et al., 2024; Opesemowo & Ndlovu, 2024). Yet, save for a tiny minority of non-users (3 students) who mentioned environmental concerns, these structural issues were entirely absent from student responses.

It would appear from this that students evaluate GenAI almost exclusively through a hyper-individualised lens: they focus on personal convenience, immediate grades, and direct learning gains, while remaining blind to the broader ethical, corporate, and environmental impacts of the technology.

5.3. Synthesis of the Framework

By viewing these findings through our conceptual framework, we can see that students' relationship with GenAI is constantly evolving. When synthesised, the three dimensions of our conceptual framework do not operate in isolation; they form a continuous, dynamic feedback loop that defines the modern mathematics student experience.

Initially, the intentional decision to adopt GenAI is driven by the perceived benefits of instant access and personalised, step-by-step mathematical explanations. However, once usage begins, the experience of that engagement immediately exposes students to its limitations: mathematical inaccuracies, notation errors, and the internal temptation to cheat or over-rely on the tool. As predicted by our framework, this exposure directly alters their ongoing perceptions. The user realises that GenAI is not a flawless computational calculator, but an unpredictable, conversational agent. This updated perception forces a shift in future usage: students either retreat from the tool (rare), use it passively to copy answers under intense time pressure, or adopt a highly critical, evaluative "sense-checking" stance that ultimately is likely to deepen their conceptual understanding. Thus, student engagement with GenAI in mathematics education is defined by this fluid balancing act, as students continually weigh the immediate rewards of 24/7, anonymous support against the long-term risks of cognitive skill loss and technical inaccuracy.

6. Conclusions

In this study, we explored, on a large scale for the first time, the reasons given by university students for their usage/non-usage of GenAI for mathematics, along with their perspectives on the benefits and challenges of using GenAI for mathematics. We anchored our analysis in a three-dimensional conceptual framework, focusing on the dynamic feedback loop between reasons for use/non-use, perceived benefits, and perceived challenges. We found that student interactions with GenAI for mathematics are characterised by an active, continuous feedback loop, where students are decision-makers who constantly negotiate the immediate rewards of these tools against their technical and cognitive risks.

Several key conclusions emerge from this theoretical synthesis. First, our findings expose a stark cognitive dissonance within the student experience. Students use GenAI with a genuine desire for self-improvement and conceptual scaffolding, yet they remain deeply anxious about the long-term threat of over-reliance and cognitive skill loss. Interestingly, the framework highlights how active users navigate the explicit challenge of mathematical inaccuracy. Rather than discouraging use, encountering errors in GenAI output forces students to adopt a critical, evaluative stance—requiring them to perform manual "sense-checks" that inadvertently deepen their mathematical reasoning.

Secondly, GenAI has fundamentally altered the architecture of mathematics learning support. The unprecedented speed of adoption of GenAI is driven by the perceived benefits of unlimited constant access and, crucially, anonymity. While educators frequently express

concern over the isolating nature of GenAI, our framework reveals that students actively prize this isolation as a safe space to make mathematical errors without fear of judgement.

Finally, this study reveals an individualist ethical blindspot among higher education students. While sensitive to localised, peer-to-peer unfairness such as continuous assessment cheating, students remain almost entirely blind to the wider-level risks of privacy, equity and bias prevalent in academic literature.

These conclusions offer vital insights for higher education institutions and mathematics educators during this time of rapid change. Such widespread usage of GenAI for mathematics has major implications for the types of assessments that can be conducted in this area, as well as student engagement with other resources that lecturers might recommend. No form of summative take-home mathematical assignment can now be regarded as robust, even when each student receives a different assignment to complete (which was one approach traditionally employed to reduce copying). The traditional mathematical examination (closed-book, timed, proctored) (Iannone & Simpson, 2022) remains a reliable assessment format even with the explosion of GenAI usage, but this format tests particular skills in a certain manner, and a variety of assessment approaches better reflects a student's overall competence (Buchholtz et al., 2018). Oral assessment is a popular assessment choice for mathematics in certain regions in Europe (Videnovic, 2020), although not traditionally in Ireland or the UK to date. Educators may now need to consider how such an approach could be incorporated into some of their assessments. It is incumbent upon mathematics departments (and higher education in general) to engage in discussions regarding their approach to assessment in this climate, and to decide whether to design in or design out the use of GenAI in their future assessments, and to what extent (Perkins et al., 2024).

Traditional MLS centres cannot compete with the 24/7 availability or the total privacy of GenAI. However, MLS retains something that GenAI cannot provide—personal human connection—and this is still valued and utilised by students. However, it is important that MLS centres continue to evolve and incorporate online supports that allow students to seek support in a range of ways.

With such high numbers of students engaging with GenAI for mathematics, it would be worthwhile for higher education institutions to give serious consideration to providing students with training in the effective use of GenAI, so that they can derive the greatest benefit from this while avoiding as many of the adverse outcomes as possible. GenAI offers many possible areas of opportunity for mathematics education, such as tailored learning, unlimited support, and step-by-step guidance, and we want our students to be able to make the best use possible of this emerging technology. Training involving effective use of prompts, ensuring outputs are considered with a discerning eye, and clearer advice about the ethical implications of its use would be of value for students. Indeed, there is value in introducing deliberate exercises where students are tasked with diagnosing and correcting the logical fallacies and notation errors generated by GenAI models, modelling how students can do this themselves when they use GenAI independently.

It would be of interest to repeat this study in the coming year, because almost a third of respondents were in the early stage of their usage of GenAI for mathematics at the time of the survey, and so it remains an open question to see if their usage has changed with time, or if they perceive any further benefits or challenges with the technology as they become more familiar with it, and as the technology itself improves.

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References

- Abdaljaleel, M., Barakat, M., Alsanafi, M., Salim, N. A., Abazid, H., Malaeb, D., Mohammed, A. H., Hassan, B. A. R., Wayyes, A. M., Farhan, S. S., Khatib, S. E., Rahal, M., Sahban, A., Abdelaziz, D. H., Mansour, N. O., AlZayer, R., Khalil, R., Fekih-Romdhane, F., Hallit, R., . . . Sallam, M. (2024). A multinational study on the factors influencing university students' attitudes and usage of ChatGPT. *Scientific Reports*, 14(1), 1983. [CrossRef]
- Ahmed, Z., Shanto, S. S., Rime, M. H. K., Morol, M. K., Fahad, N., Hossen, M. J., & Abdullah-Al-Jubair, M. (2024). The generative AI landscape in education: Mapping the terrain of opportunities, challenges, and student perception. *IEEE Access*, 12, 147023–147050. [CrossRef]
- Anastasakis, M., & Lerman, S. (2022). Tool-use profiles in undergraduate mathematics. *International Journal of Science and Mathematics Education*, 20(4), 861–879. [CrossRef]
- Baidoo-Anu, D., Asamoah, D., Amoako, I., & Mahama, I. (2024). Exploring student perspectives on generative artificial intelligence in higher education learning. *Discover Education*, 3(1), 98. [CrossRef]
- Bessant, K. C. (1995). Factors associated with types of mathematics anxiety in college students. *Journal for Research in Mathematics Education*, 26(4), 327–345. [CrossRef]
- Blahopoulou, J., & Ortiz-Bonnin, S. (2025). Student perceptions of ChatGPT: Benefits, costs, and attitudinal differences between users and non-users toward AI integration in higher education. *Education and Information Technologies*, 30(14), 19741–19764. [CrossRef]
- Buchholtz, N. F., Krosanek, N., Orschulik, A. B., & Vorhölter, K. (2018). Combining and integrating formative and summative assessment in mathematics teacher education. *ZDM*, 50, 715–728. [CrossRef]
- Buele, J., Sabando-García, Á. R., Sabando-García, B. J., & Yáñez-Rueda, H. (2025). Ethical use of generative artificial intelligence among ecuadorian university students. *Sustainability*, 17(10), 4435. [CrossRef]
- Busuttil, L., & Calleja, J. (2025). Teachers' beliefs and practices about the potential of ChatGPT in teaching mathematics in secondary schools. *Digital Experiences in Mathematics Education*, 11(1), 140–166. [CrossRef]
- Chan, C. K. Y., & Hu, W. (2023). Students' voices on generative AI: Perceptions, benefits, and challenges in higher education. *International Journal of Educational Technology in Higher Education*, 20(1), 43. [CrossRef]
- Deacon, L., & Ní Fhloinn, E. (2025). Student engagement with mathematics learning supports twelve years on. *International Journal of Mathematical Education in Science and Technology*, 57, 1163–1180. [CrossRef]
- Divjak, B., Svetec, B., & Horvat, D. (2026). Generative AI in mathematics education: Analysing student performance and perceptions over three academic years. *International Journal of Technology Enhanced Learning*, 18(1), 16–39. [CrossRef]
- Egara, F. O., & Mosimege, M. (2024). Exploring the integration of artificial intelligence-based ChatGPT into mathematics instruction: Perceptions, challenges, and implications for educators. *Education Sciences*, 14(7), 742. [CrossRef]
- Fardian, D., Suryadi, D., Prabawanto, S., & Jupri, A. (2025). Integrating Chat-GPT in the classroom: A study on linear algebra learning in higher education. *International Journal of Information and Education Technology*, 15(4), 732–751. [CrossRef]
- Farhi, F., Jeljeli, R., Aburezeq, I., Dweikat, F. F., Al-shami, S. A., & Slamene, R. (2023). Analyzing the students' views, concerns, and perceived ethics about chat GPT usage. *Computers and Education: Artificial Intelligence*, 5, 100180. [CrossRef]
- Feeney, C., & Ní Fhloinn, E. (2026). Is mathematics different? Student usage of GenAI for mathematics versus general purposes in higher education. *Teaching Mathematics and Its Applications: An International Journal of the IMA*, hrag013. [CrossRef]
- Frieder, S., Pinchetti, L., Griffiths, R.-R., Salvatori, T., Lukasiewicz, T., Petersen, P., & Berner, J. (2023). Mathematical capabilities of chatgpt. *Advances in Neural Information Processing Systems*, 36, 27699–27744. [CrossRef]
- Gogh, E., & Kovari, A. (2025). Homework in the AI era: Cheating, challenge, or change? *Frontiers in Education*, 10, 1609518. [CrossRef]
- Haddley, J. A., & Ardito, C. G. (2024). Generative AI in assessment: Towards understanding the student view. *MSOR Connections*, 23(1). [CrossRef]
- Hamel, A. M. (2024). *Math, ChatGPT, and you: The problem with mathematical accuracy in large language models* [Bachelor's thesis, Dartmouth]. Available online: https://digitalcommons.dartmouth.edu/cs_senior_theses/39/ (accessed on 19 July 2026).

- Hoernig, S., Ilharco, A., Pereira, P. T., & Pereira, R. (2024). *Generative AI and higher education: Challenges and opportunities* (pp. 1–61). Institute of Public Policy. Available online: <https://www.ipp-jcs.org/wp-content/uploads/2024/09/Report-AI-in-Higher-Education-IPP-1.pdf> (accessed on 19 July 2026).
- Iannone, P., Biza, I., Davies, B., Kinnear, G., & Nieminen, J. H. (2025, February 4–8). *Towards a research agenda for generative AI in university mathematics education*. Fourteenth Congress of the European Society for Research in Mathematics Education (CERME14), Bozen-Bolzano, Italy. Available online: <https://hal.science/hal-05238099/document> (accessed on 19 July 2026).
- Iannone, P., & Simpson, A. (2022). How we assess mathematics degrees: The summative assessment diet a decade on. *Teaching Mathematics and Its Applications: An International Journal of the IMA*, 41(1), 22–31. [CrossRef]
- Jo, H. (2024). From concerns to benefits: A comprehensive study of ChatGPT usage in education. *International Journal of Educational Technology in Higher Education*, 21(1), 35. [CrossRef]
- Joung, E., & Kim, Y. R. (2026). Exploring the impact of discussion responses generated from ChatGPT on student performance and experiences. *School Science and Mathematics*, 126(1), 89–105. [CrossRef]
- Kapur, I., Sharkey, C. N., & Ren, C. (2026). Student perspectives on artificial intelligence: Challenges, opportunities, and societal implications. *Journal of Evidence-Based Social Work*, 23(1), 150–176. [CrossRef] [PubMed]
- Kurtz, G., Amzalag, M., Shaked, N., Zaguri, Y., Kohen-Vacs, D., Gal, E., Zailer, G., & Barak-Medina, E. (2024). Strategies for integrating generative AI into higher education: Navigating challenges and leveraging opportunities. *Education Sciences*, 14(5), 503. [CrossRef]
- Larkins, J., & Seaton, K. (2024). Our cheating is not your cheating: Signature misconduct exemplified in mathematics. *Assessment & Evaluation in Higher Education*, 49(7), 994–1004. [CrossRef]
- Manik, E., Sihombing, D. I., Sianturi, R., & Simbolon, T. (2024). Using ChatGPT as a tutor to learn mathematics application program. *International Journal of Research in Education*, 4(2), 314–322. [CrossRef]
- Memiş, Y. (2025). Examining the potential and pitfalls of AI in problem solving. *Journal of Pedagogical Research*, 9(2), 177–190. [CrossRef]
- Mulaudzi, L. V., & Hamilton, J. (2025). Lecturer's perspective on the role of AI in personalized learning: Benefits, challenges, and ethical considerations in higher education. *Journal of Academic Ethics*, 23(4), 1571–1591. [CrossRef]
- Mullen, C., Cronin, A., Pettigrew, J., Shearman, D., & Rylands, L. (2025). Optimising the blend of in-person and online mathematics support: The student perspective. *International Journal of Mathematical Education in Science and Technology*, 56(2), 275–295.
- Ní Shé, C., Mac an Bhaird, C., Ní Fhloinn, E., & O'Shea, A. (2017). Students' and lecturers' views on mathematics resources. *Teaching Mathematics and Its Applications: An International Journal of the IMA*, 36(4), 183–199. [CrossRef]
- Opesemowo, O. A., & Ndlovu, M. (2024). Artificial intelligence in mathematics education: The good, the bad, and the ugly. *Journal of Pedagogical Research*, 8(3), 333–346. [CrossRef]
- Pardos, Z. A., & Bhandari, S. (2024). ChatGPT-generated help produces learning gains equivalent to human tutor-authored help on mathematics skills. *PLoS ONE*, 19(5), e0304013. [CrossRef] [PubMed]
- Perkins, M., Furze, L., Roe, J., & MacVaugh, J. (2024). The Artificial Intelligence Assessment Scale (AIAS): A framework for ethical integration of generative AI in educational assessment. *Journal of University Teaching and Learning Practice*, 21(6), 49–66. [CrossRef]
- Rane, N. (2023). *Enhancing mathematical capabilities through ChatGPT and similar generative artificial intelligence: Roles and challenges in solving mathematical problems*. Available online: <https://ssrn.com/abstract=4603237> (accessed on 19 July 2026). [CrossRef]
- Rasul, T., Nair, S., Kalendra, D., Robin, M., de Oliveira Santini, F., Ladeira, W. J., Sun, M., Day, I., Rather, R. A., & Heathcote, L. (2023). The role of ChatGPT in higher education: Benefits, challenges, and future research directions. *Journal of Applied Learning and Teaching*, 6(1), 41–56. [CrossRef]
- Razmerita, L., Mortensen, S. E., Mate-Toth, Z., & Allen, J. P. (2025). Student perspectives on generative AI use in higher education: The automation and augmentation of learning. In C. Bădică, M. Gušev, A. Iftene, M. Ivanović, Y. Manolopoulos, & S. Xinogalos (Eds.), *Proceedings of the advances in ICT research in the Balkans* (pp. 164–174). Springer Nature. [CrossRef]
- Sánchez-Ruiz, L. M., Moll-López, S., Nuñez-Pérez, A., Moraño-Fernández, J. A., & Vega-Fleitas, E. (2023). ChatGPT challenges blended learning methodologies in engineering education: A case study in mathematics. *Applied Sciences*, 13(10), 6039. [CrossRef]
- Schei, O. M., Møgelvang, A., & Ludvigsen, K. (2024). Perceptions and use of AI chatbots among students in higher education: A scoping review of empirical studies. *Education Sciences*, 14(8), 922. [CrossRef]
- Serhan, D., & Welcome, N. (2024). Integrating ChatGPT in the calculus classroom: Student perceptions. *International Journal of Technology in Education and Science*, 8(2), 325–335. [CrossRef]
- Sevnarayan, K. (2024). Exploring the dynamics of ChatGPT: Students and lecturers' perspectives at an open distance e-learning university. *Journal of Pedagogical Research*, 8(2), 212–226. [CrossRef]
- Slobodsky, P., & Durcheva, M. (2025). Using ChatGPT errors to encourage student exploration and self-learning in mathematics. *International Journal of Mathematical Education in Science and Technology*, 56(8), 1401–1425. [CrossRef]
- Strzelecki, A. (2024). Students' acceptance of ChatGPT in higher education: An extended unified theory of acceptance and use of technology. *Innovative Higher Education*, 49(2), 223–245. [CrossRef]
- Taani, O., & Alabidi, S. (2024). ChatGPT in education: Benefits and challenges of ChatGPT for mathematics and science teaching practices. *International Journal of Mathematical Education in Science and Technology*, 56(9), 1748–1777. [CrossRef]

- Thomas, D. R. (2006). A general inductive approach for analyzing qualitative evaluation data. *American Journal of Evaluation*, 27(2), 237–246. [CrossRef]
- Videnovic, M. (2020). Short guide on how to implement oral assessment in post-secondary mathematics courses: COVID times and beyond. *IMVI Open Mathematical Education Notes*, 10(1), 9–13. Available online: https://www.imvibl.org/omen/10_1_2020/omen_10_1_2020_9_13.pdf (accessed on 19 July 2026).
- Wahid, S. N. S., Yusof, Y., & Razak, M. R. (2014). Math anxiety among students in higher education level. *Procedia-Social and Behavioral Sciences*, 123, 232–237. [CrossRef]
- Walkington, C. (2025). The implications of generative artificial intelligence for mathematics education. *School Science and Mathematics*. Early view. [CrossRef]
- Wardat, Y., Tashtoush, M. A., AlAli, R., & Jarrah, A. M. (2023). ChatGPT: A revolutionary tool for teaching and learning mathematics. *Eurasia Journal of Mathematics, Science and Technology Education*, 19(7), em2286. [CrossRef] [PubMed]
- Wolfram, S. (2010, April 15). *The story of the making of Wolfram alpha*. Available online: <https://www.stephenwolfram.com/publications/making-wolfram-alpha/> (accessed on 19 July 2026).
- Wolfram, S. (2023, March 23). *ChatGPT gets its Wolfram superpowers*. Stephen Wolfram Writings. Available online: <https://writings.stephenwolfram.com/2023/03/chatgpt-gets-its-wolfram-superpowers/> (accessed on 19 July 2026).
- Wu, T., He, S., Liu, J., Sun, S., Liu, K., Han, Q.-L., & Tang, Y. (2023). A brief overview of ChatGPT: The history, status quo and potential future development. *IEEE/CAA Journal of Automatica Sinica*, 10(5), 1122–1136. [CrossRef]
- Zein, S., Yaniawati, P., & Mudrikah, A. (2024). The role and evaluation of ChatGPT as a virtual tutor in improving students' creative and critical abilities reviewed from probing-prompting abilities. *Kreano, Jurnal Matematika Kreatif-Inovatif*, 15(2), 501–517. [CrossRef]
- Zhou, R., He, X., Fan, Q., Li, Y., Li, Y., Xiao, X., & Fang, J. (2025). Exploring ChatGPT-facilitated scaffolding in undergraduates' mathematical problem solving. *Journal of Computer Assisted Learning*, 41(4), e70077. [CrossRef]

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