Students' perspectives of the use of Khanmigo as a mathematics AI tutor

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ABSTRACT

This study explores college students' experiences using an AI tutor to support their math learning. Specifically, we conducted a focus group interview of around 50 students in two sections of a college algebra class and had access to the assistance of Khanmigo, an AI-powered tutor by Khan Academy. Our results show that participants used Khanmigo to complete their homework and study for their exams, especially generating practice problems that were solved side-by-side with the AI. Overall, students had a positive experience, they learned to appreciate the benefits of the virtual tutor but also to recognize and handle the limitations of this novel tool. Most of them were also using other generative AIs for the class and are willing to continue using these technologies to support their academic endeavors. Through the lens of student experiences, we explore the strengths and weaknesses of this AI tutor and propose some strategies to improve its implementation in educational environments. Overall, our results represent a suitable source of information to reflect on the role of generative AI as a mathematics teaching assistant.

INTRODUCTION

Learning college algebra, and mathematics more broadly, can be difficult task for many college students. With the emergence of powerful generative AI (GenAI), the ways in which this technology can be implemented to support students in their mathematical learning has been a research interest over the years. Recent studies have examined the integration of such tools in mathematics classrooms, focusing on users' experiences and interactions (Park & Manley, 2024; Wardat et al., 2023). These investigations are part of a growing body of research that examines the perceptions of both students and educators regarding the use and impact of AI in higher education (Chan & Hu, 2023; Lee et al., 2024).

For this project, we focused on college algebra, a basic mathematical subject critical for students' success, as it often "serves as a terminal course for students in many majors as well as a prerequisite to courses" (Haver et al., 2007). Our aim was to investigate how AI tools can be implemented to support students in the learning process of college algebra. Specifically, we examined students' experiences using an AI tutor to support their learning of this subject. Concretely, the students had access to Khanmigo, an AI-powered tutor and teaching assistant from Khan Academy. They were asked, in different ways, to use the AI to complete diverse activities inside and outside the classroom. Through focus group interviews, we identified students' perceived benefits and limitations of using Khanmigo as a learning aid.

The following research questions guided our study.

RQ 1) What is the perception of the use of AI as a tutor before/after interacting with the software?

RQ 2) What are the perceived benefits, if any, of using AI as a tutor on the learning process of the students? What are the perceived drawbacks, if any?

RQ 3) What mathematical content is more suitable for the use of this technology?

LITERATURE REVIEW

The recent progress in machine learning has resulted in the creation of powerful tools that enable users to search, create, and summarize content in a way never seen before, in such a way that AI has become a ubiquitous technology that individuals interact with every day.

Perception of students of AI in higher education

According to Biggs and Tang 3-P model, "the way students perceive a technological innovation such as GenAI, their views, concerns, and experiences of the technology can have impact on their willingness to utilize the tool and consequently the extent to which the tool is integrated in the learning process" (Chen & Hu, 2023). With this motivation in mind, Chen and Hu explored university students' perceptions of GenAI. The researchers found that students recognized the potential of GenAI to support their learning process. This technology can serve as a virtual tutor, assist in tasks like writing, brainstorming, synthetizing information, create multimedia content and accelerating routine repetitive tasks. However, students expressed concerns about accuracy, privacy, ethical issues, and the impact on personal development, career prospects, and societal values.

To summarize, on one hand, students are optimistic about the present and future integration of these technologies into their academic and professional lives, on the other hand, students are cautious with this technology.

Use of AI in mathematics classrooms

GenAIs have demonstrated the ability to handle mathematical problems like arithmetic calculations, solving equations, matrices and calculus operations and to be an assistant of proof writing (National Academies of Sciences, Engineering, and Medicine, 2023). Hence, students in all levels of education are seeking help from these tools to succeed in their classes.

Recently, researchers have explored the use of such tools in teaching. For example, Wardat et al. examine the perspectives and experiences on the use of ChatGPT in teaching mathematics. With a mix of experiences and tasks experiments they found that instructors and learners have a mix of positive and negative perceptions of the use of AI in the classrooms. For example, users have identified that AI can be used to provide accurate, fast, and helpful answers to user's queries, however, they are concerned with the lack of human reasoning and understanding on the software, which can sometimes lead to errors or misconceptions.

In another instance, Park and Manley developed a "study to examine the capabilities of ChatGPT as a tool for supporting students in generating mathematical arguments that can be considered proofs". In thi study, students were asked to use the feedback of ChatGPT to enhance their arguments in a proof. The researches found that most students were able to improve their arguments and they found ChatGPT to be like a replacement for a peer or a coach that can give feedback and notice flaws they would not have found on their own. However other students had a

negative experience, they described their communication with the AI tool difficult and highlighted the limitations in ChatGPT's reliability.

In both students, ChatGPT was found to be a promising tool to provide support in learning mathematics, but an awareness of its limitations from students and educators is needed.

METHODS

This study employs a qualitative approach, utilizing focus group interviews to explore and address the research questions outlined above.

Study context and Participants

Our project took place at Michigan State University in two sections of 103B, a college Algebra course during the Spring 2025 semester. 103B is the second part of a yearlong course offered to students that have completed the first part, 103A, satisfactorily. Students are from humanities, business and STEM majors. Students usually take this course to fulfill the quantitative education requirement of their major or in preparation for other classes like calculus or chemistry. Habitually, students struggle with mathematics and lack either confidence or interest in developing their mathematical skills. So, the main goal of having two parts of this course is to help students build conceptual understandings in a half pace manner.

Both sections were taught by the same instructor and supported by two undergraduate teaching assistants. Classes were held twice a week, with each session lasting 80 minutes. During class time, the instructor delivered new material through a lecture-based format, interwoven with individual and group practice problems to reinforce key concepts and enhance student understanding. In addition, students have access to Webwork, an online homework system that allows students to complete practice problems and receive immediate feedback on whether their answers are correct or incorrect. These problems were not graded.

Each section consisted of 30 to 40 students. For our study, we had *participation* from 24 students in Section 1 and 31 students in Section 2, resulting in a total sample size of 55 students.

Data

All students were granted access to use Khanmigo as part of a Khanmigo Pilot Program in Michigan State University (Mauger, 2025). Khanmigo is an AI tutor developed by Khan academy, designed to support learning across a range of subjects, including mathematics, science, and the humanities. Unlike many other generative AIs, Khanmigo is specifically designed to interact with the user as a tutor. When a student asks to solve a problem, Khanmigo responds with a partial answer, followed by a leading question to build-up the solution together with the user. Rather than simply providing answers, it encourages the student to engage with the problem and work side by side with the AI to arrive at the solution.

Each section received different directions in the use of the AI throughout the semester. Students of Section 1 were encouraged by the instructor to use the software at the beginning of the semester, but the indication of its use gradually decreased in the course of the semester. Meanwhile, students of Section 2 were encouraged all semester to use Khanmigo, in particular, in the moments that students were instructed to work in their practice problems during class.

At the end of the semester, we conducted a focus group interview. Each section was divided into smaller groups of six students. The interview in each group was facilitated by different interviewers, including the author of this project, mathematics graduate students and the undergraduate teaching assistants of each section. The interview session lasted approximately 30 minutes.

We use a semistructured questionnaire (Jordan et. al., 2021): the interviewer had a framework to work with, but they conducted the focus group discussions at their own pace, allowing flexibility in whether or not to include the optional bonus questions. The interviewers were encouraged to promote balanced participation among all group members and to facilitate open conversation within the group. Responses were documented through handwritten notes taken during the interview.

The questionnaire for the interview was the following:

1) *From 1 to 5, where 1 is not great and 5 is great, how has your experience been in 103B overall?*
2) *How often are you using Khanmigo inside the classroom.*
    a. *In what ways have you used it for? (answering questions, generating ideas, checking work, studying for exams)*
3) *How often are you using Khanmigo outside the classroom.*
    a. *If you used it, what kind of activities do you use it for?*
    b. *If you did not, why?*
4) *Can you give me an example of a time when Khanmigo helped you?*
    a. *Why was it helpful at that time?*
    b. *Did Khanmigo help you improve your learning or study habits?*
5) *Were there any instances where Khanmigo provided incorrect or unhelpful information?*
    a. *Why was it not helpful?*
    b. *How did you handle it?*
6) *Did you find Khanmigo better help you in one unit/subject over another?*
    a. *Quadratic formulas, exponential functions, applications of equations …*

Bonus questions

7) *Did your opinion of AI tutors change after using this Khanmigo in these two months? Why?*
8) *If you could, would you use Khanmigo in the future? Why?*
9) *What features of Khanmigo do you find most useful, and why?*
    a. *If you could add a feature or functionality to Khanmigo which one, would it be and why?*
    b. *If you could, what is a feature you would remove/improve of Khanmigo?*

Data analysis

We perform a descriptive analysis to our gathered data (Insight, 2025). We categorized the answers of the participants into the following categories.

1) Ways or tasks Khanmigo is used
2) Perceived benefits of using Khanmigo
3) Perceived drawbacks of using Khanmigo
4) Features to improve of Khanmigo
5) Ways or tasks another AI is used
6) Perceived benefits of using another AI
7) Perceived drawbacks of using another AI
8) Use of Khanmigo and other AI's in the future

Then, we proceed to create a summary of each category. Additionally, we compared the answers between Sections 1 and 2 to inquire if the contrast of instructions changed the perception of the students when using Khanmigo.

We limit ourselves to a descriptive approach to the results and we do not provide any quantification of the findings. Our goal is to gain practical insights rather than statistical assertions.

RESULTS

Use of Khanmigo and other AI's and Features Khanmigo could improve

Students expressed they were using Khanmigo mostly outside the classroom, they used it rarely inside the classroom. Some commented they engaged with the AI when they were unable to access help from a tutor, teaching assistant, or instructor due to time or location constraints. Otherwise, they would rather seek assistance from them.

Khanmigo was mostly used to get help doing their homework and studying for their exams. In particular they asked the AI to:

- Generate practice problems to solve by their own or side by side with the AI.
- Check if their answers were correct.
- Understand mathematical terminology.
- Create summaries/breakdowns of problems.
- Identify the equations that are deduced from word problems.
- Understand the meaning of the equations.
- Discover the big picture of mathematical problems.

It is worth noting that some students were performing a subset of these tasks using different GenAIs, mostly ChatGPT and Snapchat AI. As a side note, some students found Khanmigo helpful in other subjects like chemistry, physics or biology.

First, students observed that it got easier to interact with the AI with more practice. For example, they noticed that some errors raised because they entered the wrong input, thus, they got better in writing the equations and double checking their prompt. Another example comes from the use of ChatGPT, they commented they have to be really specific writing in the prompt to receive exactly what they want.

Second, they recognized that having a basic knowledge of the subject itself (college algebra) is necessary to have a meaningful interaction with AI. This knowledge was necessary not only to formulate coherent prompts but also to accurately interpret the responses.

Third, students noticed that Khanmigo was best suited for "simple things" like factorization or asymptotes problems, as well that for tasks with numbers and word problems. However, it was not effective with more complicated problems, like long division or problems involving graphs.

Finally, some features that students think that Khanmigo could improve are:

- Receive prompts that come from pictures, in a similar fashion to Snapchat AI.
- Create graphs instead of describing them with words.
- Generate visual examples.
- Instead of being taken into a step-by-step solution have a "Give me the answer" option to check answers or a "Give me a complete example" option to visualize a complete solved problem.
- Have an App version for mobile devices.
- Improve the speed of response.

Perceived benefits and drawbacks of using Khanmigo and other AI's

On one hand, students find multiple aspects of Khanmigo helpful in their learning process of college algebra. In particular,

- Khanmigo's practice problems are found to be useful, especially since students can request them without having the answers immediately revealed.
- The step-by-step solutions of the AI are highly valued. They represent a clear and useful explanation of the problem.
- In most cases, Khanmigo provides accurate answers to the problems.
- It enables students to make progress on homework when they are stuck or unsure how to proceed.
- Khanmigo serves as a supportive, simplified tool. It uses accessible language and simplifies complex ideas.
- It helps them to discover alternative methods and new strategies to solve problems.
- The AI acts as a virtual tutor, providing guidance outside the classroom. It is an immediate help that can be accessed anytime, anywhere.

- For students with anxiety or introverted tendencies, it offers a stress-free way to ask questions without the pressure of speaking to a tutor or instructor.
- While tutors may not explain everything or assume prior knowledge from the student, the AI explains the subject from the ground and does not assume the student should know something already.

On the other hand, some aspects of the platform were not useful or unpleasant. Specifically,

- When working through a problem, Khanmigo's "follow-up question" format was frustrating for students that want to seek a full explanation, a quick and direct answer or even check their own answer.
- In some cases, Khanmigo gives incorrect or misleading answers.
- Khanmigo employs a different approach to problem-solving than the one taught in class. This can be confusing.
- Some students felt that Khanmigo over-explained certain solutions.
- Some students think Khanmigo takes longer to create the answer compared to other AI's.
- As mentioned in the last section, Khanmigo is not helpful in learning "complicated subjects" like long division.
- Khanmigo can tell if an answer given by the user is incorrect but cannot fully explain why is incorrect.
- The initial process of signing in onto the Khanmigo platform was difficult, so much so that a few never ended up using it.
- Like other AI tools, the students cannot verify if the answer given by the AI is correct.
- A few students are concerned about the environmental impact of the use of AI in general.

Present and future use of Khanmigo and other AIs

We found mixed opinions about their use now and in the future of Khanmigo. On one hand, some students held a generally negative view of GenAI tools, and their perception did not change after the semester. They prefer to use YouTube videos to reenforce their learning, solve the practice exams provided by the instructor and seek the help of humans instead of a machine. Other students change their opinion about the use of AI in a class, they acquired a new perspective of the potency of AI in education, and they are willing to explore it more.

On the other hand, most students were already using GenAIs for their academical endeavors, even of all the time. From this group, some would not use Khanmigo but rather use ChatGPT to help them with their mathematical learning and general academic endeavors. Others would not use Khanmigo for mathematics but find the platform helpful for other subjects like biology, chemistry and even general writing tasks. Finally, we have some students that would continue to use Khanmigo, and think it is a beneficial tool for the class; however, a few observed the integration in the class felt random and would like to have more instructions on how to navigate it.

Overall, students think Khanmigo, and other GenAIs are useful to study math in a convenient way, nevertheless, it is a support tool that does not replace the help of teachers and tutors. For example, they say that teachers can show shortcuts and new ways to think about problems that AI cannot or be a trustful source of answer that can verify and explain the reasoning behind the solution of a problem.

Comparison of Sections 1 and 2

The students of Section 1 that received a more constant reminder of Khanmigo used the platform more widely and deeper than students of section 2. The former students were able to comment on instances where Khanmigo was helpful or not as well as the features offered by Khanmigo. The latter mostly used other Ais like ChatGPT and overall were not willing to use Khanmigo in the future.

DISCUSSION

In this research, we conducted a focus group interview of college students to explore their experience using Khanmigo, an AI tutor, that supported their learning in a college algebra class. The investigation specifically concentrated on the perceived benefits and drawbacks of using the AI as a tutor in mathematics. Our findings highlight the potential of Khanmigo as a virtual tutor as well as its limitations. Also, most participants showed a positive attitude toward using Khanmigo and other AIs to help them in their mathematical learning.

Khanmigo experience as an AI tutor

The study reveals that Khanmigo has a strong potential to serve a virtual tutor that assists and supports the student in learning mathematics while complementing the instructional efforts of educators. For example, the AI is anywhere, anytime available in contrast to the specific places and times an instructor or tutor could be available. Additionally, it offers a supportive learning environment for students who may feel anxious, intimidated or not well served by interactions with human tutors. However, Khanmigo, like any other AI, is a supplement and not a replacement for human instruction: it lacks proximity, flexibility and mathematical intuition and reasoning of human tutors as well as the pedagogical expertise of the instructors.

Khanmigo's distinctive approach of guiding students through problems by a step-by-step solution prompted by the learner was highly appreciated by many. Students appreciated how the virtual tutor broke down complex processes into manageable parts, explained terms and concepts clearly, and used accessible language throughout. However, this same feature was also a source of frustration for some, as the process could feel lengthy or excessively detailed, making it less efficient for those seeking quicker solutions.

In a similar way that students got better interacting with Khanmigo with the practice, we believe that students can learn to handle this format, recognizing this step-by-step process is helpful and

should not be skipped in the process of learning mathematics, then, after they are more knowledgeable, they can look for other alternatives when their objective is checking their answers.

Likewise, students sought alternatives when Khanmigo provided inaccurate responses. These limitations could be partially offset by the user's own subject knowledge; according to students' feedback, the use of the AI tends to improve when they have a stronger grasp of the material and a better understanding of math. Learners also turned to other resources for problems involving long division, graphing, or tasks requiring visual support, as Khanmigo was perceived as less effective in those areas. Overall, these challenges are expected to diminish as the software continues to evolve and improve.

Finally, the study shows that students' knowledge of Khanmigo and the exposure to the tool in class are positively correlated. This suggests that hands-on experience and sustained used in the classroom may help students to be willing to interact with AI and have the chance to make the most of it. Additionally, students expressed a desire for more seamless integration into classroom routines, sometimes the activities felt disjointed and that the sign-in process was difficult.

Based on these findings, we recommend that the initial access to Khanmigo be made as seamless as possible. Instructors are encouraged to highlight the platform's strengths during class and design engaging activities that promote meaningful interaction with the AI. This approach can help students become more comfortable with the tool and encourage them to extend their learning experience beyond the classroom by using Khanmigo independently, if they choose to do so.

The perception of the use of AI in the classroom

AI technologies are replacing the way we interact with information and have impacted several teaching and learning practices. We have found, as we would reasonably expect, that most students are using GenAIs for their classes, even all the time. Hence, researches have explored the implementation of AIs in math classroom (Wardat et al., 2023; Park & Manley, 2024). Our findings are in line with these studies: we received a mix of opinions from the students using Khanmigo. Some students find Khanmigo a knowledgeable assistant, a trustworthy source of guidance when no one else is around to help them. In the same way, other students found the interaction with the AI a lengthy or difficult process, then, it was not helpful and looked for alternatives to help with their learning process.

We expect that our study will contribute with the increasing recognition that AI technologies offer several opportunities to improve learning inside and outside the classroom. At the same time, as educators, we should continue to find strategies to make AI a beneficial agent in learning, acknowledging its limitations and mitigating the negative impacts AI could have in the learning process, for example, getting a quick answer without an actual learning process.

CONCLUSION

In this study, we conducted a focus group interview of college students to explore their experience using Khanmigo, an AI tutor that supported their learning in a college algebra class. The results show that students generally have a positive experience using Khanmigo and other generate AIs to complete their assignments and study for their exams. Overall, students have learned to appreciate the benefits of using this technology but also recognize and handle the limitations of these novel tools. Most of them are willing to continue using them to support their academic endeavors.

Drawing on students' perspectives, we identified several benefits of using Khanmigo, such as being an immediate guide that can be accessed anytime, anywhere, as well as its ability to generate useful practice problems accompanied by clear, step-by-step explanations. In contrast, students also noted certain drawbacks, including the perception that responses were sometimes overly slow or excessively detailed, and that the AI struggled with more complex problems. Based on these insights, we offer recommendations for the effective integration of Khanmigo into classroom instruction. Overall, our findings provide a valuable foundation for reflecting on both, the promise and the challenges of generative AI as a supportive tool in students' learning process.

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