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AI-Enhanced Open Pedagogy: A Case Study in Mathematics Education

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Abstract*:* This study aimed to expand OER's impact by positioning students as creators of knowledge rather than passive consumers. Students designed renewable assignments, openly licensed their work, and used AI tools as partners for brainstorming, exploring alternative problem-solving approaches, and refining content. Survey results showed that most participants preferred the AI-enhanced Open Pedagogy approach over traditional assignments, citing reduced stress, improved critical thinking, and better understanding. Many used AI tools like ChatGPT and Copilot to verify answers, generate questions, and simplify explanations, while emphasizing that their work reflected their own understanding. Students also expressed enthusiasm for sharing projects publicly, contributing to the growing body of OER. Findings suggest that combining Open Pedagogy with AI promotes reflection, deeper engagement, and active learning. However, students largely created OERs in a limited format, highlighting the importance of brainstorming a variety of approaches with students including interdisciplinary applications when designing OERs, which can inspire creative approaches to Open Pedagogy early on. A future direction includes coding student-created questions into MyOpenMath for global sharing. This study represents an initial step toward transforming mathematics education through AI-enhanced Open Pedagogy.

Keywords—Open Education Resources; Open Pedagogy; Artificial Intelligence (AI)

1. INTRODUCTION

Textbooks have long been essential to college education, yet their escalating costs have become a major barrier to student access and success. Their rising costs have prompted institutions to seek affordable alternatives such as Open Educational Resources (OER) which are free, openly licensed materials that can be reused, adapted, and shared. OER courses often include zero-cost textbooks, scholarly articles, videos, interactive assessments, and digital tools accessible on any device. Instructors can tailor these resources to their teaching style and address diverse student needs, promoting equity and inclusion.

At York College, a City University of New York located in Jamaica Queens, the pandemic accelerated efforts to adopt OER in gateway mathematics courses, resulting in substantial cost savings for students. By leveraging free resources and interactive OER platforms such as MyOpenMath, students gained flexible, accessible learning materials while reducing financial burdens. To evaluate the impact of these initiatives, a researcher in the Mathematics & Computer Science department at York conducted a study examining OER use in precalculus courses. Findings (Thompson & Wallach, 2023) revealed that most participants rated the quality of the free textbook as equal to or better than traditional textbooks used in other courses. Moreover, when comparing OER sections to non-OER using common final exam scores, the analysis found no significant differences in student achievement. These results align with broader research indicating little or no difference in learning outcomes between OER and traditional materials (Hendricks et al., 2017; Hilton, 2016; Ozdemir et al., 2017; Grimaldi et al., 2019). While these findings affirm that OER saves money without harming academic performance, York missed exploring pedagogical changes with OER.

In David Wiley, a leading voice in the OER movement view, saving significant amounts of money without harming learning outcomes is clearly a win-win situation (Wiley, 2013). However, he argues that even greater victories can result from OER implementation, a goal York College pursued in this case study.

DeRosa and Jhangiani (n.d.) posed a critical question: "How can OER impact the learner community far beyond textbook cost?" Wiley was one of the first to answer this question when he addressed how the use of OER could transform pedagogical styles in the course when students have opportunities to contribute to education resources, not just be consumers of it, which is called Open Pedagogy (Wiley, 2013). He proposed replacing "disposable assignments", work students complete, receive a grade for, and then discard (as to toss it in the garbage), with "renewable assignments", ones where students openly license their work, share it publicly on the web, contributing to the growing body of OER.

This case study aimed not only to transform traditional assignments into renewable ones by openly licensing students' work, but also to integrate Artificial Intelligence (AI) tools (not for quick answers), but as collaborative partners in exploring precalculus concepts, brainstorming multiple solution paths, and creating meaningful content. By combining Open Pedagogy with AI, this initiative positions students as active

creators of knowledge, amplifies their voices, and fosters a sense of belonging in the mathematics classroom.

2. LITERATURE REVIEW

2.1 OER and Open Pedagogy

First, confirm that you have the correct template for your paper. The term Open Educational Resources (OER) was formally introduced in 2002 at the UNESCO Forum on the Impact of Open Courseware for Higher Education in Developing Countries (UNESCO, 2002). UNESCO later defined OER as "teaching, learning and research materials in any medium, digital or otherwise, that reside in the public domain or have been released under an open license that permits no-cost access, use, adaptation and redistribution by others with no or limited restrictions" (UNESCO, 2012). The OER movement gained momentum through pioneers such as David Wiley, who coined the term "open content," developed Open Content licenses, and co-founded Lumen Learning, laying the legal and conceptual foundations for OER. Richard Baraniuk contributed significantly through OpenStax, a nonprofit that provides free digital textbooks widely adopted across the United States. Similarly, David Lippman, a community college math professor and OER advocate, created IMathAS in 2005, the open-source software behind MyOpenMath (Tan et al., 2021). MyOpenMath has since expanded adoption across universities, saving students millions by offering accessible homework and course management tools at no cost (Khoule et al., 2021). Initially, institutions embraced open textbooks primarily to reduce costs; however, over time, attention shifted toward the pedagogical opportunities offered by OER, enabling students to create and remix educational materials rather than simply consume them.

David Wiley is credited with defining the term Open Pedagogy around 2013, emphasizing opportunities for students to create OERs rather than discarding their work. Instead of "throwing away" knowledge, students can produce new artifacts or edit and remix existing resources, making them freely available for others (Clinton-Lisell, 2021; Panke, 2024). Clinton-Lisell (2021) conducted a systematic review of Open Pedagogy practices, extending beyond the basic use of OER, reporting generally positive experiences among both faculty and students. Her review highlighted Hilton's findings (Hilton et al., 2019, 2020), which suggest that students who engage in Open Pedagogy develop stronger critical thinking skills compared to those in traditional settings, likely due to their involvement in creating, evaluating, and improving their own work based on feedback. Clinton-Lisell also noted research by Al Abri and Dabbagh, as well as Masterman, which revealed that students expressed greater fulfillment in renewable assignments than in traditional ones and emphasized how Open Pedagogy fosters active learning (Al Abri & Dabbagh, 2019; Masterman, 2016). Faculty responses mirrored student feedback, reporting positive experiences implementing Open Pedagogy. However, Clinton-Lisell observed that while many educators adopt OER, not all transition to Open Pedagogy. She believes this may be due to their primarily focus on cost savings rather than how to make pedagogical changes with OER.

2.2 AI and Open Pedagogy

The template is used to format your paper and style the text. The introduction of AI into education began in November 2022 with tools such as ChatGPT and Microsoft Copilot (Dempere et al., 2023). These AI systems, based on natural language processing, are designed to simulate human-like communication with users. Since 2023, universities have increasingly integrated AI into teaching and learning, and this trend continues to evolve. Today, almost any conversation regarding technology in education will mention the use of AI, as it is reshaping how knowledge is delivered and acquired, marking a significant paradigm shift in education (Siddiqui et al., 2025). AI offers personalized learning experiences by tailoring content to meet individual student needs (Akavova et al., 2023).

According to Panke (2024), combining Open Pedagogy with AI has the potential to enhance students' creativity and productivity, particularly through non-disposable assignments. While extensive literature highlights AI's benefits, such as, generating alternative ways to express ideas, developing arguments, supporting collaborative problem-solving, acting as a co-designer, offering tutoring, and analyzing and summarizing data, Panke notes that there are still few documented examples of successful integration of AI with OER.

3. STUDY PURPOSE

This project aims to address that gap by presenting outcomes from a case study at York College, where Open Pedagogy was implemented in a precalculus course. Students were encouraged not to discard their learning but to showcase it by creating OER materials and openly licensing their work for future learners. Beyond creating OER, students also integrated AI tools as collaborative partners, using them to explore concepts, brainstorm solutions, co-creating educational content.

The research questions (RQ) that guided this investigation are as follows:

RQ1: What do students in the precalculus course identify as valuable, motivating, or challenging about the AI-enhanced Open Pedagogy approach?

RQ2: How do students perceive their experience with AI-enhanced Open Pedagogy compared to traditional classroom activities in statistics?

RQ3: In what ways do students engage in creating renewable assignments and openly licensed resources in the statistics course when supported by AI tools?

4. METHODOLOGY

After the text edit has been completed, the paper is ready for the template. This study was conducted during the Spring and Fall semesters of 2025 at York College. Two sections of the precalculus course, each with 30 registered students, were invited to participate. Both sections utilized the OpenStax Precalculus textbook and MyOpenMath, a free online homework and assessment platform.

The instructor began teaching the course by introducing students to Open Educational Resources (OER), emphasizing their benefits, particularly cost savings and immediate access to learning materials. She shared her commitment to OER as a response to the high cost of traditional textbooks and online homework systems. To extend the conversation beyond affordability, the instructor posed a guiding question to her students: How can OER impact students far beyond getting free textbook and online homework? and What do you usually do with your graded assignments after they are returned to you? The second question sparked laughter, as most students admitted they typically discard their work. These questions served as a springboard for introducing the Open Pedagogy project.

The Open Pedagogy project accounted for 5% of the course grade and challenged students to create openly licensed educational resources based on the mathematical concepts they learned throughout the semester. To guide students, the instructor provided examples of possible contributions to OER, including:

- Adding original problem sets and solutions to the professor's final exam review.
- Creating handouts on precalculus topics with worked-out solutions.
- Contributing discussion questions or problem sets to existing open textbooks or forums.
- Developing supplementary learning resources to enhance understanding of key concepts.
- Design guides that explain complex topics with examples and step-by-step solutions.

Students were organized in small groups to work collaboratively together with the intent of them supporting one another to brainstorm ideas for their projects. The instructor emphasized that AI tools could be used for brainstorming, to expand their thinking, exploring alternative approaches to problem solving and not for simply providing answers. She also reminded students of AI's limitations and its potential to provide inaccurate information; a point students appeared to understand. Although students worked in groups for idea generation, each was required to submit an individual OER project for grading. Additionally, students were given the option to openly license their work using a Creative Commons license or to keep it private. The instructor provided a form for students to indicate their choice, clarifying that their decision to share or not share their work would have no impact on their grade.

4.1 Instruments Used

A survey was developed and administered to students at the end of the both Spring/Fall 2025 semester and used to gather students' perceptions, attitudes, challenges, and overall experiences with the AI-enhanced Open Pedagogy approach, addressing RQ1 & RQ2. The instrument included multiple-choice and Likert-type items, as well as open-ended questions. Student-created OER artifacts (renewable assignments) were used as evidence of engagement and production. The student's Open Pedagogy projects will be used to answer RQ3.

5. DATA ANALYSIS

The researcher used SPSS (Statistical Package for the Social Sciences) to analyze students' quantitative data, generating tables and percentages to describe the outcomes. Microsoft Copilot was used as an AI-assisted tool to support the analysis process. Specifically, it helped summarize patterns from the responses. For qualitative data from open-ended survey questions, it produced initial codes, identify themes, and group similar responses under representative labels. To ensure accuracy and credibility of the AI-assisted coding process, the researcher manually reviewed student responses alongside the AI-generated codes and refined them as necessary to preserve data integrity and ensure that students' ideas were accurately represented.

6. RESULTS

A total of 36 students over two semesters completed the survey. The researcher believes there was a low turnout for survey responses due to students either dropping the course, not 18 or older as the IRB guidance required students to be at least 18 to fill out the survey, or the student simply did not fill it out.

Among them, 30.6% majored in Computer Science, 16.7% in Biology, 11.1% in Pharmaceutical Science, 8.3% in Chemistry, and 2.8% in Aviation. The remaining 30.5% reported "Other," were undeclared, or did not provide a response. Most participants had completed two or fewer semesters at York College.

The following Survey Results answers RQs 1 & 2

6.1 Prior Experience with OER and Open Pedagogy

Most students entered the course with little prior exposure to Open Educational Resources (OER). When asked, "Did you know about OER before taking this class?" 94.4% responded No. Similarly, 91.7% had never completed an assignment similar to the Open Pedagogy project, indicating this approach was new for nearly all participants.

6.2 Perceived Educational Value

When asked to compare the educational value of the Open Pedagogy project to traditional activities (e.g., papers, quizzes, exams), 86.1% reported the project was better, 13.9% said it was about the same, and no student indicated it was worse. Students cited reduced stress, creativity, and deeper understanding of mathematical concepts as key benefits. Comments included: "Allows for creativity and choice; less stressful than quizzes or exams." and "Being on the other side of math, creating the question really helped me understand the concepts better." Others emphasized collaboration and confidence-building such as to say, "Group work helps us collaborate and incorporate teamwork." and "It helps students feel confident in themselves and express ideas." Those who felt the experience was similar to traditional activities noted its resemblance to homework saying "Still answering questions and showing work like I would do in class."

6.3 Learning Outcomes

Students identified several learning outcomes from the project. Many reported a deeper understanding of precalculus concepts, such as to say, "In order to create a question for studying, you have to understand the material." Others highlighted improved problem-solving and critical thinking, for example "Forces critical thinking, improves memory, and helps you really check your understanding." Additional themes included reinforcement of prior learning ("refreshed my mind on past lessons"), increased confidence, and opportunities for self-assessment.

6.4 Preference for Future Courses

When asked to imagine a future required course with two sections, one using traditional activities and the other incorporating Open Pedagogy, 63.9% said they would prefer the Open Pedagogy section, 27.8% had no preference, and only 8.3% favored traditional activities. Students who preferred Open Pedagogy cited active engagement, hands-on learning, reduced stress, and creativity saying, "It allows you to be active with the class and engage with what's going on", and it "Allows me to show what I know without the stress." Others appreciated grade flexibility, saying "Having the opportunity to complete a project for a grade helped reduce the weight of the exam percentage."

6.5 Sharing Work Publicly

Regarding sharing their Open Pedagogy projects online, 63.8% chose to make their work available for reuse by others. Reasons included helping future learners, supporting open education, and personal satisfaction: "It feels good to know I'm contributing to something that will help others", and "I felt like there was no harm in sharing it, and it might help the people who come after me."

6.6 Perceived Benefits of Open Pedagogy

Students emphasized that Open Pedagogy promotes deeper understanding, creativity, and active participation, saying the following comments: "They can make their own equations, leading to a better understanding of the course.", "Gives students a chance to be part of the class." , "Reveals gaps in understanding, which encourages students to get a better grasp of the topic." and "helps identify where you need improvement and areas you aren't good at."

6.7 Potential Disadvantages

Although most students (61.1%) saw no disadvantages (or potential problems) in teaching with Open Pedagogy in mathematics, 36.1% identified potential issues, including errors in student-created materials, over-reliance on AI, uneven topic coverage, the need for quality control, and the risk that free resources might contain mistakes compared to paid textbooks.

6.8 AI Usage

AI usage was common, with 69.4% of students reporting they used AI tools. ChatGPT was the most frequently used, followed by Copilot, Gauth, and Gemini. Students reported that they used used AI primarily to verify answers, generate or refine questions, explain steps in simpler terms, and create graphs or visualizations. Some noted drawbacks such as occasional incorrect answers or overly complex explanations, which they addressed by asking AI to simplify responses.

6.9 Student Perceptions of AI

Survey statements (See Table 1) revealed that most respondents agreed AI tools helped them complete and improve their projects, though fewer felt AI significantly enhanced their understanding of mathematical concepts, most did agree. Importantly, a majority indicated that their work represented their own understanding rather than simply presenting AI-generated content, and using AI did not impact their ability to complete the project task. The table below also shows the percentage of students who did not respond (DNR), leaving their perception of using AI unreported.

Table 1: Student Perceptions of AI

Statement	SA	A	N	D	SD	DNR
The AI tools overall helped me you to complete project	13.9	36.1	11.1	11.1	2.8	25.0
The AI tools helped me better understand the mathematical	19.4	27.8	19.4	2.8	8.3	22.2

concepts in the project						
Using the AI tools helped me to perfect my project	22.2	38.9	11.1	2.8	2.8	22.2
I relied on my own understanding of the mathematical concepts and not the AI tool when I used it for the project	27.8	30.6	13.9	5.6	0.0	22.2
My work for the project represented my own understanding of the material and not just presented information provided by AI	41.7	30.6	2.8	2.8	0.0	22.2
Using AI for this project impacted my ability to complete the task of the project	8.3	13.9	13.9	16.7	25.0	22.2

SA- Strongly Agree, A- Agree, N-Neutral, D- Disagree, SD- Strongly Disagree, DNR- Did Not Respond

The following (Figure 1 and 2) shows Examples of Student-Created Work which will answer RQ3

To guide students through the project, the instructor provided examples of possible ways student could contribute to OER, such as: adding original problem sets and solutions to the professor's final exam review which was already openly licensed, creating handouts on precalculus topics with worked-out solutions, contributing discussion questions or problem sets to existing open textbooks or forums, developing supplementary learning resources to reinforce key concepts, and designing guides that explain complex topics with examples and step-by-step solutions.

Ultimately, every student chose to add original problem sets and solutions to the professor's final exam review; not one student ventured out to create another type of OER. Each student produced at least one precalculus-related question accompanied by a worked-out solution. Below are examples of submitted projects, illustrating questions designed by students that could be included among the review materials for the final exam. Created questions were related to precalculus topics such as solving exponential, logarithmic and trigonometric equations, finding the domain and range of functions, analyzing polynomial functions and more.

Figure 1: Example of Student's Open Pedagogy Project

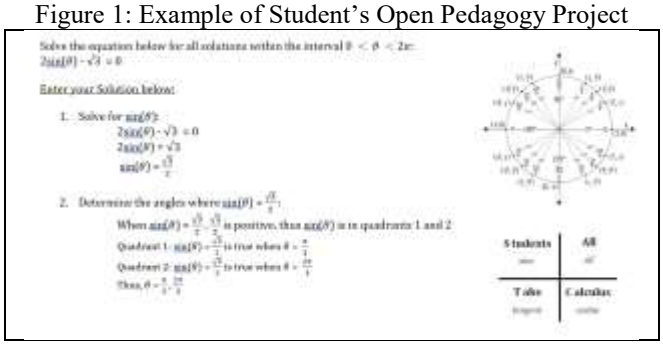
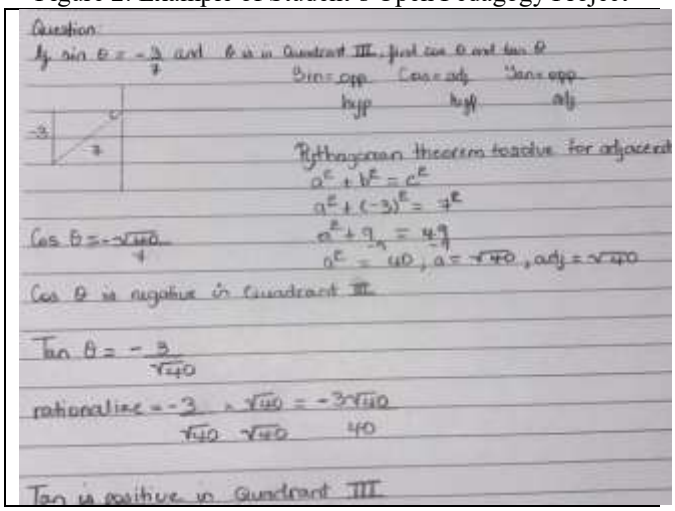


Figure 2: Example of Student's Open Pedagogy Project



7. DISCUSSION

The goal of this research was to move beyond cost savings associated with OER and toward Open Pedagogical approaches, which create opportunities for students to actively participate in the learning process and position them as creators of knowledge rather than passive recipients (Shah, 2019). Most students in the study were unfamiliar with OER and had never completed an assignment similar to the Open Pedagogy project. A majority of students reported that this type of assignment was better than traditional ones, (Lazzara et al., 2024; Hilton et al, 2019) describing it as less stressful and helping them feel a sense connection to the class. The project provided them with the opportunity to self-reflect, think about past lessons and check their understanding of a topic.

By exploring solution paths and synthesizing mathematical ideas while creating their projects, students developed a deeper understanding of the content (Cargas et al., 2017). They were able to identify areas for improvement and take ownership of their learning. This aligns with Short et al. (2024), who found that Open Pedagogy approaches empower students, allowing them to be more in charge of their learning and taking more responsibility of their learning.

Students were given the option to use AI as a partner in exploring precalculus concepts and brainstorming ideas for content creation. A majority agreed that AI supported their understanding of mathematical concepts. However, they emphasized that the work they submitted reflected their own understanding rather than AI-generated answers, and most admitted they relied primarily on their own knowledge rather than the AI tool. Overall, students acknowledged that AI was helpful in the process and contributed to their comprehension of the material.

Although students were offered multiple options for designing OER, all chose to contribute questions and worked-out solutions for the professor's final exam review. This limited the variety of OER created and suggests that students may have felt more comfortable with this option due to their lack of exposure to actually student-created OERs, particularly in mathematics. It is also possible that students selected this approach as a way to prepare for the upcoming final exam. The researcher believes that if students had seen examples of diverse OER projects from previous semesters or online resources, they might have explored more creative approaches. Nevertheless, researchers believe that this is just a start, enabling her to see the value her students find in being creators and not just consumers of content which deeply resonated with her. Regarding sharing their Open Pedagogy work, most students chose to make their projects openly available for reuse, hoping to support future learners.

8. Limitations and Future Directions

The use of AI in teaching and learning is still in its early stages. This case study illustrates how AI can serve as a supportive partner when integrated with Open Pedagogy approaches. Reflecting on the implementation, the researcher notes that introducing the project earlier in the semester and providing examples of different directions students could have taken with creating OERs, could have encouraged students to explore more creative approaches for the project. For instance, students could have created OERs that connected precalculus concepts to their fields of study. Given the variety of majors represented such as Biology, Computer Science, Pharmaceutical Science, Chemistry, and Aviation, this approach could have encouraged interdisciplinary connections with mathematics. Additionally, the researcher felt she should have incorporated AI and highlighted what responsible AI looks like and examples of good prompts, ensuring that students understood how to use these tools thoughtfully and productively.

Looking ahead, the Open Pedagogy initiative at York College envisions collaboration between upper-level Computer Science students and Computer Science faculty to code student-created questions into MyOpenMath. MyOpenMath is an open-source program, allowing questions to be programmed into its database and shared globally. By contributing York College students' questions to this widely used platform, the institution can expand its impact on Open Pedagogy and support a broader community of mathematics educators and learners.

9. Conclusion

The purpose of this case study was to explore how integrating Open Pedagogy with AI tools can impact student learning experiences in a precalculus course, shifting students from simply benefiting from free resources to having opportunities to create and openly license their own work. This case study represents an initial step in York College's implementation of Open Pedagogy for mathematics. The researcher envisions greater victories in future implementations and is committed to building on this foundation.

10. Acknowledgments

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