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AI Co-Teaching in Statistics: Exploring Student Learning and Perceptions with Google NotebookLM

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The rapid evolution of artificial intelligence (AI) technologies has transformed educational practices across disciplines, yet empirical evidence on human-centric AI co-teaching remains limited. This study examines the use of Google NotebookLM as a source-grounded cognitive partner in undergraduate and graduate statistics courses. Participants were students enrolled in undergraduate and graduate courses during the Fall 2025 semester, from whom data were collected in the form of course assignments and reflective writing. A qualitative thematic analysis was conducted on assignment artifacts and reflection data, as this approach allows patterns to emerge inductively and is well suited to the exploratory nature of the study. We identified four primary themes which demonstrate that Google NotebookLM can function as an AI co-teacher to support students' conceptual understanding, procedural mastery, real-world application, and metacognitive development. These findings suggest that source-grounded AI tools can function as effective cognitive co-teachers when embedded within structured instructional design; however, there is a need for cautious interpretation of the learning benefits and further investigation using other research methods when more data become available.

Keywords: Artificial Intelligence, Google NotebookLM, Statistics Education, AI tutor, AI Co-Teaching, Engagement, Co-Agency

INTRODUCTION

Numerous studies have demonstrated the benefits of AI in education, particularly its potential to improve learning through personalized feedback and real time support (Pan and Gu, 2023; Al Harrasi et al., 2025; Niloy et al., 2025; Zhang et al, 2025). However, little research has been done to understand the role of AI as a co-teacher, particularly within the field of statistics. As a collaborative instructional model, co-teaching has long been used to improve learning output, offer diverse perspectives, and provide timely support via collaboration between two instructors who share teaching responsibilities (Walther-Thomas, 1997; Lock et al., 2016). Traditionally, one faculty member needs to pair with another faculty or a teaching assistant to conduct co-teaching. Due to the rapid development of AI, the Human-AI co-teaching model calls for additional attention; a novel approach needs to be examined fully.

Recent research has begun to explore AI's potential to promote engagement and improve learning outcomes. Results suggest that instructors' technological self-efficacy and institutional support play a key

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role in incorporating ChatGPT into inquiry-based learning to improve engagement (Adeyele and Ramnarain, 2024). Similarly, recent studies show that AI can improve teaching engagement, particularly when teachers feel more confident with technology (Ding et al. 2025). Niloy (2025) also found that using generative AI in blended learning improved student engagement and conceptual understanding when guided by clear instructional and ethical frameworks. Although these studies documented the potential and concerns about the AI integration in education, most studies were conducted from the teacher's perspective rather than the students' point of view. Moreover, much of the existing research has treated AI as a tool rather than as a teacher.

The introduction of Google NotebookLM has changed how AI is perceived, transcending a tool-only view. Tufino (2025) describes NotebookLM as a Google Gemini-powered AI platform that integrates Retrieval-Augmented Generation (RAG) for improved accuracy and reliability, positioning it as an active learning partner and a collaborative tutor. Given the above roles, NotebookLM can help instructors summarize and prepare course materials based on reliable sources such as textbooks, PPT slides and journal articles while assisting students' learning by clarifying concepts, offering step-by-step guidance, and verifying results. In this framework, AI plays a role as a co-teacher who is good at delivering course content from instructor provided- sources and offering timely feedback and guidance. That is, instructors have more time for course design, prompt development and guidance since AI takes on a secondary role in content delivery and immediate feedback. Meanwhile, both human instructors and AI co-teachers engage students and facilitate learning in innovative ways, echoing Zhou's (2025) findings on the changing role of instructors and the view of learning as a co-constructed process involving AI, students, and instructors.

Tufino (2025) is one of the few researchers who has incorporated Google's NotebookLM as a collaborative AI tutor in physics education. In his study, NotebookLM was shown to reinforce accuracy and analytical reasoning by using instructor-curated sources. Similarly, Sikri and Nuguri (2025) adopted a three-dimensional framework in which NotebookLM was treated as a thinking partner to support collaboration and content creation. They documented the potential of NotebookLM as a collaborator and reinforced its pedagogical flexibility. The teacher's role in curriculum design and delivery has been transformed as AI takes on the role of a collaborator who promotes educational practices (Zhai, 2024).

Statistics courses are difficult and demanding due to students' math anxiety and limited self-efficacy. Hernández de la Hera et al. (2023) examined how affective factors in mathematics and statistics education, namely anxiety, self-efficacy, and attitudes, relate to academic performance. Their findings indicate that math anxiety is negatively tied to students' attitudes toward both mathematics and statistics and identified as the strongest predictor of academic performance. Beyond cognitive skills, students' emotions and motivation play a significant role in how they learn mathematics and statistics. Effective instructional design therefore needs to address anxiety and boost students' confidence.

Statistics education provides a natural setting for us to explore the impact of AI co-teaching on statistics learning since many existing studies viewed AI as a learning tool rather than a co-teacher. Little research has been done to explore its role as a teaching partner (Chen et al., 2023). The present study seeks to bridge this gap by leveraging Google NotebookLM as an AI co-teacher to examine how AI co-teaching enables students to learn statistics in a more active and effective way.

The study addresses the following research questions:

1. How does AI-assisted guidance within the co-teaching framework help students formulate conceptual understanding of statistical concepts?
2. How does Human-AI co-teaching assist students in procedural learning and fluency?
3. How do students transfer AI-supported statistical learning to real-world scenarios?
4. How does AI co-teaching contribute to the development of students' metacognitive awareness, reflection and AI literacy?

LITERATURE REVIEW

AI IN HIGHER EDUCATION

Since the introduction of ChatGPT, artificial intelligence (AI) tools have emerged as transformative technologies, responding to growing demands for immediate and intelligent information delivery (Hosseini et al., 2023; Adeyele & Ramnarain, 2024). In education settings, the adoption of AI has increased rapidly, as more educators have recognized the value of integrating AI into the classroom to provide personalized feedback, enhance student engagement, and improve learning outcomes (Pan & Gu, 2023; Adeyele & Ramnarain, 2024; Giannakos et al., 2025). AI tools such as ChatGPT have been widely recognized as capable of supporting rapid evaluation and providing timely feedback in educational settings (Bhuiyan et al.,2025). However, there are notable challenges and risks that need to be addressed when integrating AI tools into courses. For example, there are growing concerns that students may increasingly depend on AI to generate answers for exams and homework assignments and to write papers, which may contribute to academic dishonesty and plagiarism (Bin-Nashwan et al, 2023). Dependence on AI may be detrimental to meaningful learning and critical thinking when students submit AI-generated work as their own without engaging with or understanding the material (Jose et al.,2025).

Researchers have also explored the relationships among students' characteristics, patterns of AI use, and perceptions of AI. It has been observed that AI can offer personalized instruction, immediate feedback, and interactive learning to better meet students' different learning needs. Students were reported to treat AI as a supplement rather than a replacement for human instructors. Similarly, Alenezi (2025) also concludes that AI should be used as a learning assistant and should not replace human instruction. The same author also reported that AI-supported language learning significantly improved students' motivation and self-efficacy via guided self-paced practice and immediate feedback. Furthermore, Chen et al. (2026) documented improved human-AI collaboration through a theory-driven dashboard in writing, and they also reported increased cognitive load compared to simple interactions in the control group. In addition, AI has proven to improve procedural proficiency, though it does not necessarily improve deep learning. Integrating AI effectively requires sound pedagogical methods if it is to help instructors to achieve optimal outcomes and help students improve their critical thinking and promote active engagement (Jose et al., 2025).

Many studies have well-documented the benefits of the integration of AI; however, limited research examined the impact of AI co-teaching on the learning of statistics. To bridge this gap, the current study investigated AI co-teaching via Google NotebookLM in two university statistics courses, one at the undergraduate level and one at the graduate level. The goals of this study are to understand how AI co-teaching supports students' conceptual understanding, procedural mastery, application, and metacognitive awareness in statistics education. The findings of the study are expected to contribute to the growing literature on AI-enhanced pedagogy and provide insights into how NotebookLM can effectively serve as a collaborative partner for teaching and learning in higher education.

STATISTICS EDUCATION AS A CASE CONTEXT

Statistics education is an important testbed for AI co-teaching due to the subject's unique challenges. Students often struggle with low confidence and high levels of math anxiety, which can undermine their performance and make it harder for them to persist in STEM programs (Ramirez et al., 2013). Statistical instruction at both the undergraduate and graduate levels continues to face familiar challenges. Many students struggle to understand abstract ideas, such as probability distributions and inferential reasoning, and are often discouraged by the mathematical rigor involved (Wahba et al., 2024).

Recent studies have demonstrated that AI has the potential to address several challenges. Ellis and Slade (2023) showed that ChatGPT holds real promise for teaching statistics and data science, and they argued that instructors should guide students to learn how to prompt, evaluate, and use AI-generated responses responsibly to promote deeper engagement and better understanding. Similarly, Wahba et al. (2024) emphasized that when ChatGPT is used in a responsible manner, it can help students better understand difficult concepts and reduce the anxiety that often comes with learning statistics. Along the same lines,

Bray (2024) argued that AI platforms in quantitative fields can help students make sense of challenging ideas by providing clear explanations, different ways to think about problems, and step-by-step guidance as they work through assignments and assessments. Furthermore, DeLuca et al. (2025) emphasize that AI can improve learning in writing-based statistics courses when it is used thoughtfully. They argue that instructors should purposely design activities that motivate students to reason, reflect, and critically evaluate ideas, rather than simply rely on AI outputs. Writing remains essential for building statistical expertise because it asks students to put their thinking into words, which helps students to develop reflective skills that cannot be fully replaced by AI.

Prior research has mostly viewed AI as a support tool, not as an active co-teacher in the learning process. In contrast, traditional co-teaching models show that when instructional responsibilities are shared, teaching becomes more effective as students receive more support and engage with course materials in multiple ways (Johnson & Johnson, 2018). Inspired by the co-teaching model, this study investigates how Google NotebookLM, as an AI co-teacher, assists students in understanding statistical concepts, mastering procedures, applying knowledge, and developing metacognitive awareness, and how it helps create a more interactive and reflective learning experience in statistics courses.

AI AND THE RECONFIGURATION OF TEACHING ROLES

Co-Teaching in Education

Co-teaching provides an effective approach to supporting students by bringing diverse perspectives and expertise from at least two instructors into the classroom. Its goal is to reduce teacher isolation and prepare them to better support students in K–12 settings (Friend & Cook, 2017). Multiple studies have documented that co-teaching plays a critical role in strengthening course design, supporting professional development for teachers, and creating richer learning experiences for students (Zach & Avugos, 2024). In addition, interdisciplinary co-teaching not only improves student learning and communication, but also affects how students come to understand scholarship itself (Richter et al., 2025). Given the importance of the co-teaching approach, integrating AI as a co-teacher in the classroom may benefit both instructors and students when the co-teaching framework is properly implemented. By adding an AI partner to the classroom, students can benefit from the combined expertise of human and AI instructors. Despite AI's growing use, there is still a lack of studies examining AI co-teaching models in the current literature.

Google NotebookLM and Its Features

NotebookLM is powered by Google's Gemini LLM and retrieval-augmented generation (RAG) and is designed to support both teaching and student learning. Its interface consists of three main areas. In the Sources panel, users can upload and organize materials supported by the platform, such as PDFs, Google Docs, and YouTube links. The Chat panel allows students and instructors to interact with AI through dialogue. The Studio panel provides tools for generating output such as reports, mind maps, infographics, and multimedia overviews (Google, October 2025).

Recent research shows that NotebookLM supports students in tracking their learning progress and helps them become more active learners (Lineman et al.,2025). Students can take AI-generated quizzes and practice key concepts and knowledge using AI-generated flashcards, which make them more engaged with the course materials. Wang and Liu (2025) investigated how university students interacted with AI tools, including ChatGPT and NotebookLM, within a Predict–Observe–Explain (POE) learning design. The study found that when students engaged with AI in a structured and inquiry-driven way, they asked more reflective questions, became more aware of their own thinking, and developed a deeper understanding of key concepts. It seems that NotebookLM has the potential to be an effective AI co-teacher who helps students become active learners and support their AI literacy.

By using peer-reviewed OpenStax materials, Google NotebookLM provides students with more trustworthy academic content while minimizing potential bias (Google Workspace Updates, 2025). In this way, NotebookLM can help minimize hallucinations and errors. Moreover, features such as audio and video overviews can be leveraged to transform static course materials into podcasts and videos through NotebookLM, therefore, it offers an innovative way to promote active learning. NotebookLM helps

instructors better tailor learning experiences to individual students. For instance, audio overviews provide an easy, conversational way for students to review key concepts/ideas, which is especially helpful for those who prefer listening or need to study on the go. Video overviews, mind-maps and infographics offer visual support to help students make sense of abstract concepts and complex topics through visually guided explanations. In other words, NotebookLM delivers multimodal learning experiences that allow students to engage with the same course materials in different and innovative ways, addressing diverse learning needs. In addition, instructors can transform existing lessons into podcasts and videos through Google NotebookLM, offering more flexible and accessible ways for students to engage with course materials (Acar, 2025). Given these capabilities, the current study plans to incorporate NotebookLM as a co-teacher into our statistics courses to investigate how AI co-teachers help students in statistics learning through the advanced features of Google NotebookLM.

AI: Google NotebookLM as a Co-Teacher

As a co-teacher, AI shifts from being a simple support tool to an active partner in teaching and learning. Prior studies on AI tutoring demonstrated that AI provides feedback and personalized learning to students in real time (Tufino, 2025; Niloy et al., 2025). Google NotebookLM goes a step further, engaging students in adaptive dialogue and offering multimodal explanations that support deeper understanding. NotebookLM, as an active co-teacher, can collaborate with both instructors and students. For example, NotebookLM helps improve the learning process by delivering personalized feedback and real-time guidance for students, while helping instructors streamline instructional preparations by creating focused audio and video resources on specific topics and generating quizzes and flashcards.

Earlier studies have demonstrated the potential of NotebookLM in promoting teaching and learning. Dihan et al. (2024) leveraged NotebookLM as an AI research assistant to help improve accessibility and engagement in ophthalmology education by converting course materials into podcasts. Similarly, the Tufino (2025) paper demonstrates how NotebookLM can support learning through retrieval-augmented generation (RAG) and AI-based tutoring. Tufino (2025) treats NotebookLM as a collaborative tutor in physics-education settings. As an assistant, it helps organize content, generate study guides, and produce multimedia materials such as videos and audio summaries. Tufino (2025) describes how the system uses teacher-provided documents to ground responses, and how it generates targeted questions, study guides, and supplementary materials. NotebookLM can play a significant role in improving both teaching efficiency and self-regulated learning (Reyna,2025). Varuvel Dennison et al. (2025) implemented Shiksha Copilot in low-resource Indian schools and found that AI reduced teacher workload and expanded students' access to educational resources. The researchers also emphasized the importance of the human instructors in the co-teaching process, and of always keeping the human teacher in the loop. This aligns with the AI co-teaching model, where the teacher leads instructional decisions and AI strengthens capacity through planning and scaffolding support. In our co-teaching framework, Google NotebookLM will serve a similar role to Shiksha Copilot, as it offers more powerful capabilities and is better suited to the needs of our courses.

As shown in Table 1, our co-teaching framework consists of human instructors, students, Google NotebookLM, and its byproduct, an AI tutor. In this framework, the human instructor is responsible for curating and preparing core course materials. The human instructor can use NotebookLM to generate multimodal support (e.g., podcasts, videos, study guides) and to design a structured AI co-teacher environment for guided learning. NotebookLM and AI tutor assume responsibility for providing step-by-step guidance, real time feedback, and curated examples aligned with course learning objectives. Students can interact with both human instructors and an AI co-teacher to receive support for their learning.

Table 1. Actors and Roles of the Co-Teaching Model

Actor	Primary Functions	Relationship in Co-Teaching Model
Instructor (Human Teacher)	Curates and uploads core course materials. Uses Google NotebookLM to generate multimodal supports (e.g., podcasts, videos, study guides) and to design a structured AI Tutoring environment for guided learning.	Oversees both the AI Tutor and student-created notebooks.
Custom AI Tutor (Instructor-Configured NotebookLM)	Serves as a structured AI environment based on instructor sources. Offers step-by-step guidance and timely feedback	Supports procedural accuracy and conceptual understanding.
NotebookLM (Platform — Student-Created Notebooks)	Students upload their own materials to create summaries and flashcards to better understand the course materials. They are also encouraged to engage in independent exploration.	Personal Learning Space — fosters autonomy, creativity, and self-directed learning.
Student	Uses the Custom AI Tutor for guided practice while also experimenting independently with NotebookLM to explore new ideas, clarify doubts, and reflect on progress.	Active Learner — co-constructs knowledge through both structured and open inquiry loops.

METHODOLOGY

RESEARCH DESIGN

This study utilized a qualitative exploratory case study design centered on an instructional experiment supported by Google NotebookLM. The goal of this study was to explore in depth the participants' experiences with Google NotebookLM as a co-teacher to examine how it affected students' understanding of statistical concepts, real-world applications, and attainment of learning objectives, given its powerful capabilities for supporting self-directed learning and personalized feedback. Within the AI co-teaching framework, students can learn at their own pace, think more deeply about what they understand, and use statistical tools to make sense of real-world problems. Based on the above AI co-teaching model, the study explored how AI co-teaching environments can enhance student engagement and build confidence in statistics in higher education.

RESEARCH CONTEXT

This study employed a convenience sampling method to recruit students enrolled in quantitative analysis courses at a state university in the northeastern United States between September 1 and December 15, 2025. The instructor taught three sections of an undergraduate Business Statistics course, which is required for all students in the College of Business, and one section of a graduate statistics course. The research was situated within the Business Statistics courses, where Google NotebookLM was integrated as a pedagogical co-teacher.

PARTICIPANTS

Participants included 58 undergraduate business students enrolled in the course and 10 graduate students enrolled in the graduate-level course. Participation in the study was voluntary and approved under IRB exempt status. About 40 students contributed their assignments and reflections to the study. These

students came from diverse academic backgrounds within the College of Business and possessed varying levels of AI literacy.

DATA COLLECTION

In our course design, we brought together a range of course materials (including textbook chapters, PowerPoint slides, and YouTube videos) and organized them within Google NotebookLM to support and guide the learning process. Additionally, we implemented an AI tutor powered by Google NotebookLM in the classroom. The Statistics Tutor was trained using reliable sources such as course textbooks, JMP materials, and PowerPoint slides to reduce the likelihood of AI-generated inaccuracies. More precisely, we uploaded the textbook by Illowsky & Dean (2019) to Google NotebookLM as part of the resources since it is available online as a PDF. We also converted the chapter PowerPoint slides into PDF files and uploaded them to Google NotebookLM. In addition, the PDF file of JMP® 18 Multivariate Methods (JMP Statistical Discovery LLC, 2024) and other related materials were added since the instructor used JMP to teach the statistics classes. Finally, we provided a Stat Tutor Concise Interaction guide, which outlines specific rules for "Stat Tutor" interactions and prioritizes brevity and structure in all responses. In practice, instructors can customize the Stat Tutor to better meet the specific needs of their students.

In this study, students were encouraged to interact with the Statistics Tutor to clarify statistical concepts and procedures and to request real-world examples to support deeper understanding of the course materials. Students also had the option to create their own notebooks, audio summaries, videos, and study materials to support personalized learning. Because the tutor generates responses grounded in verified course resources, the risk of AI-produced inaccuracies is minimized. Throughout the semester, students completed several AI-supported assignments as instructed. At the end of the semester, we collected students' homework assignments and reflection reports and conducted data analyses on these materials.

AI: Homework assignments and Reflective report

Students were required to use Google NotebookLM to complete homework assignments in accordance with the guidelines provided. Specifically, they were assigned two tasks using Google NotebookLM: one focused on the Z-score, Empirical Rule, and Normal Distribution, and the other on Simple Linear Regression. We provided the first assignment overview (Appendix 1, -Table A1) to enable readers to understand the goals, instructions, and requirements of the assignment. The second assignment followed the same format. For both assignments, students received detailed instructions and supporting materials to guide them in creating their own notebooks and completing tasks with assistance from the NotebookLM and AI tutor. Moreover, students were asked to follow instructions to create stories around key statistical concepts, which helped make the material more engaging and less intimidating. Finally, students recorded and reflected on their interactions with AI during homework activities, generating rich qualitative data for this study.

DATA ANALYSIS

In this study, we followed Braun and Clarke's (2006) six-phase framework to conduct thematic analysis on students' assignments and reflections. In the familiarization phase, we repeatedly reviewed all selected assignments and reflection reports to gain a holistic understanding of how students engaged with Google NotebookLM as an AI co-teacher and what they learned from the human and AI teachers. During the initial coding phase, meaningful phrases were identified and given labels, such as "AI guidance," "confidence," and "concept understanding." During theme development, related codes were grouped into broader categories; for example, "AI guidance," "AI tutor," "thinking partner," and "research assistant" were put under the theme of AI partnership. During the review phase, themes were checked for consistency across reflections, and all references to AI feedback were grouped under AI partnership. In the defining and naming phase, each theme was refined to capture its core meaning. For example, Procedural Learning was defined as how AI supported students in mastering statistical procedures such as calculating Z-scores. Finally, in the reporting phase, an analytical narrative was developed to synthesize the findings and incorporate illustrative excerpts that highlighted students' voices. For instance, one participant reflected,

"NotebookLM helped me understand the Z-score formula step by step. I used to just memorize it, but now I know what it means." This reflection was coded as step-by-step AI guidance, from memorization to understanding, concept grasp of Z-score, which were subsequently grouped under the overarching themes of the AI-enhanced conceptual understanding.

Three sections of undergraduate statistics courses and one section of a graduate statistics course contributed data to the analysis. Both the undergraduate and graduate sections completed the same AI-assisted assignments. After the data were collected, each section was analyzed separately. Based on the analysis of each section, we observed that there are minor variations in terms of the themes across the sections. For example, in the first assignment, students in the graduate section tended to provide more detailed and reflective responses than those in the undergraduate sections, and they adhered more closely to the assignment instructions. Regarding the theme of procedural leaning, graduate students (one section) reported that Google NotebookLM, or the AI tutor, helped them clarify procedural steps and verify answers, and they emphasized that interactive questioning deepened their understanding of the course materials. Graduate students also expressed a preference for AI-supported, self-paced exploration over traditional lecture-based learning. For the undergraduate section (one section), students emphasized hands-on calculations. They reported that computing Z-scores and applying the Empirical Rule clarified how far each value lies from the mean and made probability concepts more tangible. Interactions with NotebookLM, or the AI tutor, supported learning by providing step-by-step guidance and clear explanations of the underlying reasoning processes. After conducting analyses for each section, we consolidated the identified themes into four overarching themes, which helped address our research questions.

Table 2. Phases of Thematic Analysis (Braun & Clarke, 2006)

Phase	Purpose	Example in Our Study
1. Familiarization	Read and reread the data to gain an overview.	Read all reflection reports on NotebookLM-assisted learning.
2. Initial Coding	Label meaningful ideas or phrases.	Code for "AI guidance," "confidence," "concept understanding."
3. Searching for Themes	Group similar codes into broader themes.	Group "thinking partner," "AI tutor," and "Research Assistant" under AI Partnership.
4. Reviewing Themes	Check whether the themes fit the data consistently.	Verify that all mentions of "AI feedback" are captured in AI Partnership.
5. Defining and Naming Themes	Clarify what each theme means and its significance.	Define Procedural Learning as "how AI supported students' mastery of Z-scores."
6. Reporting	Write an analytical narrative supported by examples.	Use quotes from reflections to illustrate each theme.

RESULTS

In this section, we present the findings derived from students' assignments and reflections. Participants' statements are quoted within the text to illustrate key insights, following the principle of authenticity in qualitative reporting as recommended by Lingard (2019). The results are organized around two assignments. For each, we first introduce a coded summary matrix, followed by a discussion linking the research questions to the major emergent themes. As shown in Appendix 2-Table A1, the matrix illustrates the relationship among key themes, subthemes, example codes, representative excerpts, and interpretive insights drawn from students' reflections on AI co-teaching using Google NotebookLM. As presented in Appendix 2-Table A2, four major themes emerged, which included students' conceptual, procedural, applied, and reflective learning in the statistics courses. The theme conceptual understanding helped us address Research Question 1 (RQ1). The findings of the study reveal that AI explanations and visualizations

helped students develop a clearer understanding of concepts such as the Z-score, bell curve, and empirical rule, compared to rote memorization without AI support.

For Research Question 2 (RQ2), the theme of procedural learning highlights AI's role as a step-by-step guide that helps students build confidence in problem solving and improve computational accuracy through immediate feedback and interactive AI support. As one student noted, "*With NotebookLM, I didn't just get the answer—I understood each step, and that made me more confident.*" Students also emphasized that AI scaffolded their approach, helped them follow its logic, and summarized the steps in ways that clarified their understanding. With interactive AI support, students can understand formulas and connect statistical concepts to real-world problems during computation. As one student shared, "*Doing a couple calculations out on my own helped me understand how these problems are presented in real-life settings, and how to use and understand formulas. The AI tools I was provided offered an interactive, interesting way to look into these details and learn more information.*" Another wrote that, "*The way I did those calculations and those steps did help me understand the probability was by asking the notebook the specific questions, and understanding what the answers of those questions did entail.*" Through these interactive experiences, students became more confident in solving statistical problems. For example, on student commented, "*understanding probability and variation helps make sense of uncertainty and decision-making in the real world. I feel more prepared to solve statistical problems that are thrown my way. With the help of AI tools like NotebookLM, my problem-solving skills become much better and faster*".

For application and transfer (RQ3), AI suggested real-world examples that made it easier for students to connect statistical concepts and theories to practical contexts. These applications spanned domains such as business, healthcare, sports, and manufacturing, illustrating how classroom concepts transfer to real-world contexts. As one student remarked, "*Getting a real-life example of the empirical rule really helped me understand it more thoroughly and now I think I could relate to the real-world using my own examples.*" Another student wrote that, "*I learned a lot about how these concepts could apply to the real world. An example of this is how the AI explained that Z-scores can make test scores from other classes comparable to each other.*" The reflections indicate that students were developing a growing ability to apply statistical reasoning to real-world decision-making.

With respect to the theme of meta-learning and reflection, which addresses Research Question 4 (RQ4), students demonstrated growth in self-regulation and AI literacy by reflecting on their own thinking and evaluating AI outputs. Most students mentioned the responsible use of AI in their reflections. For instance, one student noted, "*Using AI tools like NotebookLM helped guide my thinking, but I had to do the critical thinking myself.*" Moreover, students also described their learning as a guided journey supported by both human instructors and AI co-teachers. As one shared, "*This did end up reinforcing the responsible use of AI as an aid rather than a substitute for my work.*" Overall, these reflections show that students were adopting the AI co-teaching mindset by evaluating AI outputs, comparing perspectives, and integrating feedback from both humans and AI to strengthen their understanding. This shared learning space nurtured greater confidence, independence, and curiosity.

As shown in Appendix 2-Table A3, four major themes were identified: conceptual understanding, procedural learning, application and transfer, and meta-learning and reflection. Collectively, these themes illustrate different aspects of students' AI-assisted learning experiences, which are supported by related codes, student quotes, and interpretive insights. Appendix 2-Table A4 presents the results of the simple linear regression assignment and demonstrates how AI-assisted co-teaching with Google NotebookLM facilitated conceptual understanding, procedural mastery, real-world application, and reflective learning. Regarding regression research question #1 (RQ1), students progressed from memorization to high-level reasoning via AI's plain explanation, visualization and storytelling. Students can prompt AI to clarify concepts such as slope, intercept, and R^2. One student noted, "*Using NotebookLM helped me clarify definitions and structure my thoughts. Instead of memorizing formulas, I understood their meaning. Regression now feels less like a math problem and more like a tool to understand the world*." Another student added, "*Utilizing Google NotebookLM helped me to engage with these concepts in everyday language. The tool walked me through exploring the definitions and examples and even generating a story to apply the math to a real-world scenario*." Other students also pointed out that NotebookLM provides

multimodal learning to meet their diverse learning needs. Students can ask NotebookLM to generate infographics, mind-maps, stories, and videos to help them better understand the concept of regression and the relationship between the numerical variables.

For procedural mastery and confidence (RQ2), students noted that NotebookLM's scaffolding features strengthened their conceptual understanding by making each stage of the computation process transparent. Rather than simply reproducing results, they were guided through the logic behind each step. As one student explained, "*Using NotebookLM makes learning these ideas easier. It guided me through creating scatter plots and fitting regression lines step-by-step. The explanations of terms and outputs boosted my confidence in applying regression techniques correctly*." Another remarked that the tool "*helped me follow the reasoning behind each part of the solution instead of guessing the formula*." This step-by-step guidance helped students gain more confidence in applying statistical methods to solve real world problems. One student commented, "*I gained confidence using NotebookLM and understanding how regression connects variables*." Moreover, students even treated AI as a "*coach*" who could provide step-by-step guidance and immediate feedback that helped students reduce stress and boost confidence.

Regarding the application and real-world integration of regression (RQ3), AI-generated examples and narrative explanations helped students more effectively grasp regression analysis. These AI supports clarified regression's relevance across disciplines and improved students' ability to turn statistical results into actionable insights. One commented, "*I realized how regression is useful far beyond homework. In business, it can show how marketing dollars affect sales, in health, it can explain how diet or exercise influence outcomes, and in education, it can guide teachers in understanding what habits predict student success.*" Students also recognized regression as a practical reasoning tool for decision-making and problem-solving. Another student reflected, "*Before, I thought regression was just another formular, but now I see it's a way to tell a story with data.*" Others noted, "*Regression can predict sales based on advertising or forecast recovery time in medicine,*" and "*Johnny realized that the hotter the weather, the more cups of lemonade he sold.*" These reflections reveal that students were able to apply statistical thinking beyond the classroom and demonstrate successful knowledge transfer.

Regarding research question #4 (RQ4), students described how the AI co-teacher helped them improve AI literacy, increase their awareness of responsible AI use, and develop metacognitive awareness. Students described how AI helps them keep track of what they understood, assess the quality of explanations, and develop more self-directed learning habits. For example, one student remarked, "*Using NotebookLM helped me understand it in a way that made sense, and I didn't just copy stuff I actually wrote it in my own words*." Another student wrote that, "*As far as skills gained, I am becoming more comfortable using AI in general, especially NotebookLM. The storytelling exercise showed me another example of how versatile AI is and how many applications I can have if you use creativity*." Furthermore, several students highlighted the importance of using AI responsibly, viewing NotebookLM not as a shortcut but as a collaborative tutor that supports their learning. One student shared, "*I used AI responsibly, as a tutor to clarify and reframe ideas, but kept the explanations and narrative in my own words*." Another student commented, "*I learned to use AI responsibly—not as a shortcut to do the work for me, but as a collaborative tool to enhance my own learning, asking it to explain, not just answer. This combination of data literacy, clear communication, and ethical technology use is exactly what I'll need for my future career*." These reflections captured students' metacognitive growth and underscored the role of AI as a collaborator.

FINDINGS

Our results demonstrate that the integration of NotebookLM in statistics classes helps address some of the challenges and issues faced by statistics instructors. Students reported positive experiences with the AI co-teacher, who was accessible, responsive and supportive at all times. In addition, the AI co-teacher offers multimodal learning features to accommodate students' learning style and pace, where human instructors may have limited capacity to do so. With the help of AI co-teachers, students become less intimidated and stressed, gain confidence in solving problems, and change their perceptions of statistics.

In summary, the thematic analysis of students' assignments and reflections identified four key themes: conceptual understanding, procedural learning, application and transfer, and meta-learning and reflection. These four themes address the research questions and show how the AI co-teacher via Google NotebookLM supports students in understanding concepts, mastering procedures, applying knowledge, and developing metacognitive awareness. Therefore, NotebookLM can serve as a pedagogical co-teacher in statistics education to help reduce barriers to statistical learning and improve learning outcomes by improving student engagement and personalized feedback and support. Below, we summarize our findings according to the research questions.

RQ1: How does AI-assisted guidance within the co-teaching framework help students formulate conceptual understanding of statistical concepts?

Four key themes emerged under Research Question 1. First, students emphasized that AI-assisted explanations helped clarify fundamental statistical concepts such as slope, intercept, and the coefficient of determination (R^2). For example, one student remarked: "*Using NotebookLM was helpful because it allowed me to upload data and ask questions in simple terms. I asked it to explain slope, intercept, and the R^2 value in ways I could easily understand.*" Second, many students reported that AI-supported visual or story-based learning improved their comprehension by turning abstract concepts into accessible narrative- or image-based explanations that clarified complex topics. That is, AI provides explanations in plain language and can convert abstract concepts and complex topics into narrative or image-based explanations, thereby deepening students' understanding of these concepts. One student commented in his regression assignment, "*I prompted Google NotebookLM to describe and explain each topic through this assignment. Its responses included sectioned descriptions of each with several examples as well. Not only did I read through its results, but I also used the AI tool to generate a video overview. This similarly helped me to understand the ideas a little better, as seeing them put into a moving visual drew my attention further*." Another student also appreciated the time savings and made the following comment: "*Having access to information quickly is very helpful and important. Instead of going through sixty or more slides myself to find one piece of information or figure out how to do something in Excel, I can get what I need right away*."

Moreover, the AI co-teaching model enables statistical concepts to be framed as meaningful stories rather than isolated formulas. Google NotebookLM assisted in generating clear, accessible narratives, transforming assignments into stories about patterns and probability. The Z-score became a map showing where one stands in relation to the average, and the bell curve unfolded as a portrait of normality, capturing how most things in life cluster around the middle. The Empirical Rule emerged as a shortcut to predictability, helping students anticipate where most outcomes are likely to fall. With human and AI instructors offering complementary perspectives, students came to realize that statistical reasoning goes far beyond mere computation. It tells a story about patterns and narratives that explain how the world operates, revealing an underlying order within apparent randomness.

RQ2: How does AI-supported co-teaching assist students in procedural learning and fluency?

Procedural mastery and confidence emerge as the second theme that is central to Research Question 2. Students reported that they became more confident in carrying out statistical procedures when AI provided step-by-step guidance that helped them understand the logic behind each step and check their calculations. One student noted that, "*I used NotebookLM to understand the assignment by continuously requesting that it break down the definitions and give me step by step guides on how to use the formulas*." Through AI step-by-step guidance, students became more confident in conducting statistical procedures. In addition, most students described the AI as a "procedural coach" that does not give answers directly but instead provides step-by-step hints and guides students to think through problems and arrive at solutions on their own. Overall, with AI support, students built stronger procedural fluency and achieved more meaningful learning.

RQ3: How do students transfer AI-supported statistical learning to real-world scenarios?

The third research question was addressed by the theme of application and real-world integration. AI provides students with examples that help them better connect statistical concepts to real-world applications.

Through these examples, students get an idea about how statistical models such as regression and probability can be applied to real word problems to aid decision-making. Students cited examples such as analyzing product quality, interpreting exam results, and understanding variability in health data. One student reflected, "*From a health perspective, you could use regression analysis to determine the relationship between the number of daily steps someone takes and their weight loss. This would likely show a positive regression line, indicating that as you take more daily steps, you are expected to lose more weight.*" This reflection shows that students recognize the practical value and experiential relevance of statistical models. Through interaction with AI, a mindset of continuous inquiry develops, motivating students to explore the world of statistics with greater confidence and adaptability. One student noted, "*This is the only class I've taken in my years of college that asked us to use AI. I find it incredibly valuable to have prompts that help me obtain the initial information I'm looking for, and then the AI takes it from there—it asks if I need additional information, more examples, or things explained in another way*."

In summary, AI helped students expand their understanding of statistics and recognize its relevance to real-world problems across various domains. Students developed an appreciation for how statistical reasoning helps explain fairness, prediction, and uncertainty in daily life. They no longer viewed statistics as merely mathematical subjects but as practical tools for solving real-world problems. Such examples helped students bridge the gap between statistical concept/ theory and everyday life. Students no longer viewed AI as merely a tool, but as a "coach" that complements the human instructor and makes statistics more approachable and meaningful.

RQ4: How does AI co-teaching contribute to the development of students' metacognitive awareness, reflection and AI literacy?

In this study, students showed growing metacognitive awareness as they reflected not only on statistical concepts and how to apply them, but also on the way their own learning developed over time. The results of this study support existing research showing that students tend to become more self-regulated and achieve better academic outcomes when they use metacognitive strategies to plan, monitor, and reflect on their learning (Zimmerman, 2002; Pintrich, 2004). Through their interactions with the AI co-teacher, students became more aware of their learning habits and were able to identify which approaches, including storytelling, step-by-step questioning, or visualizations, best supported their learning. These reflections suggest that students started to take greater ownership of their learning and to treat AI as a partner in building self-regulation and confidence. Several students also noted that interacting with AI helped them recognize their own learning preferences, particularly a preference for visual and step-by-step explanations. Moreover, the integration of AI in this course nurtured a growth mindset by helping students become more confident, more reflective, and more ethically mindful learners. Thus, AI was not viewed as a shortcut but as a collaborative mentor that enhances students' curiosity, critical thinking, and lifelong learning skills. One student noted, "*The prompts provided for the AI help me understand the questions I should be asking to grasp the subject at hand. This is incredibly useful for me moving forward in this class and others. I love being able to ask it questions and pinpoint what I'm really trying to know—not to copy the answer, but to truly understand a topic.*" Another student commented, "*Beyond the assignment, I strengthened my critical thinking by connecting numbers to real meaning, improved my storytelling by explaining data in simple words, and practiced using AI responsibly as a learning partner rather than just a tool for quick answers*."

These reflections indicate that students recognized the importance of responsible AI use, such as validating results and checking the accuracy of AI-generated responses. Students also valued the support from both the human instructor and the AI co-teacher, as it helped boost their confidence and improve learning efficiency.

DISCUSSION

The findings of this study show that AI-assisted co-teaching with Google NotebookLM offers a promising way to combine human instruction with flexible, technology-based support in statistics education. The results of this study demonstrate that Google NotebookLM can function as a pedagogical collaborator

that supplements human instruction and enables instructors to facilitate student learning in ways that differ substantially from their traditional role of content delivery. In addition, students benefited significantly from the AI co-teacher powered by NotebookLM, which helped them move beyond memorizing formulas toward deeper conceptual understanding and statistical reasoning. For example, students developed a deeper understanding of normal distribution, Z scores, and simple linear regression through analogies and story-based explanations, and visualizations such as mind-maps and infographics.

Students also commented that NotebookLM functions as a "coach" by providing step-by-step guidance and immediate feedback, which helps them feel more confident when solving statistical problems. In this way, the AI coach can take on a secondary role in supporting procedural learning, enabling instructors to devote more time to higher-order activities such as fostering critical thinking and promoting the ethical use of AI. The results are consistent with the active learning approach, which emphasizes student engagement, conceptual understanding, and timely feedback (Freeman et al., 2014; Richter et al., 2025). Our co-teaching model using Google NotebookLM also strongly supports active learning by providing timely feedback and engaging students more deeply with statistical ideas. In this sense, AI co-teaching represents a modern extension of active teaching strategies, empowering students to become active learners rather than passive recipients.

One notable finding was that students were able to carry their statistical reasoning beyond the classroom. This reflects the concept of transfer of learning, the ability to apply knowledge and skills developed in one setting to new situations, which has long been recognized as a core goal of education (Bransford, Brown, & Cocking, 2000; Perkins & Salomon, 1992). Recent developments in generative AI and AI-based tutoring systems enable students to apply what they learn to tackle real-world problems via AI-supported explanations and examples (Hu et al., 2025; Zerkouk et al., 2025). Our findings show that AI-supported learning helped students connect regression and normal probability models to real decision making in areas such as business, education, and healthcare. Their ability to move from calculations to meaningful interpretation reflects the well-established principle of transfer of learning (Bransford et al., 2000).

With the support of AI co-teachers, students not only gain knowledge and procedural skills, but also develop meta-cognitive awareness, reflection and AI literacy. When students interact with AI, they need to check AI outputs, verify their accuracy, and incorporate insights into their own reasoning, which is believed to improve self-regulated learning (Anders & Dux Speltz, 2025) and AI literacy (Ng et al., 2021). That is, students become aware of what they understand and what they do not, identify their preferred learning strategies, and recognize both the benefits and risks of using AI, as well as how to use it responsibly.

In this study, NotebookLM emerges as a collaborative learning partner that helps students build knowledge together. In statistics learning, students made steady progress in understating statistical concept, mastering procedures and developing AI literacy, which supports a human–AI collaborative agency framework in education (Alfredo et al., 2024). Overall, the findings support a clear shift toward human–AI collaboration in statistics education.

CONCLUSION

As AI continues to develop rapidly, the integration of AI co-teaching is expected to benefit both students and instructors in an innovative and effective way. The findings of this study are consistent with recent research, including Alfredo et al. (2024) and Richter et al. (2025). Alfredo et al. (2024) investigated models of human–AI co-agency in education, while Richter et al. (2025) emphasized that co-teaching remains an effective instructional model that supports both instructors and students.

To fully realize the benefits of AI co-teaching, it is important to recognize the challenges that come with its adoption. AI co-teaching may need to align with institutional AI policies; however, many institutions currently lack mature AI guidelines for teaching. At the course level, instructors must use their professional judgment to determine how best to integrate AI co-teaching into their classes. To incorporate AI into the classroom successfully, instructors will need to develop their AI literacy before they can help students in navigating AI-generated explanations. Otherwise, it is difficult for them to craft effective prompts, design assignments, and guide students in using AI responsibly. In addition, instructors should be

aware that students come to the classroom with different levels of AI literacy (Ng et al., 2021), and that some students need more help and guidance on how to verify information, validate sources, and use AI responsibly (Anders & Speltz, 2025). Consequently, instructors need to take an active role in teaching students how to engage with AI critically, model strategies for verifying information, and create structured opportunities for responsible use. Our findings also indicate that while most students had positive experiences with NotebookLM, a small number felt disappointed, describing it as less "creative" compared to tools like ChatGPT. This reaction often came from not understanding how NotebookLM works, because its responses are limited to the materials provided by the instructor and users, meaning it focuses on accuracy and course alignment rather than open-ended creativity. Thus, it is recommended that students take an Introduction to AI and a prompt engineering course earlier in their college studies.

In summary, alongside human instruction, NotebookLM proved to be an adaptive teaching partner that supports shared knowledge building. The findings of this study are consistent with the emerging views of human-AI co-agency in education (Alfredo et al., 2024). In this approach, instructors and AI each contribute different but closely connected forms of support. In the future, we expect to see increased human-AI partnerships that contribute meaningfully to teaching and learning.

LIMITATIONS

While the findings of this study provide insights into the pedagogical potential of AI co-teaching with Google NotebookLM in statistics education, there are several limitations that need to be pointed out. First, one key limitation of this study is the potential for early adopter bias. Because the instructor was highly motivated and more willing to experiment with innovative instructional practices, which may have positively influenced both instructional quality and student perceptions. As a result, the findings may reflect favorable implementation conditions that are not necessarily typical across all teaching contexts. Second, we recognized the possibility of self-selection bias. Students who chose to participate in this study and actively engaged with the AI co-teacher may have been more open to innovative instructional practices and more receptive to new AI technologies. This predisposition could have influenced their experiences and reflections, which resulted in positive findings. That is, the sample may not be representative of all learners, especially for students who are less confident about new technologies. Thus, the qualitative insights should be interpreted cautiously and shaped by the specific context of the study. In future research, a more diverse sample of students across different institutions is needed to better understand how these findings can be applied across broader learning settings. Third, the study was conducted at a single institution and relied on a limited set of assignments for data analysis within statistics courses. Moreover, the qualitative data relied mainly on students' written reflections and assignments, which may be influenced by self-reporting bias or students' assumptions about what instructors expect to see. As a result, the findings may not generalize to other disciplines, educational levels, or AI tools with different features and capabilities. To address the above biases, future research should include instructors with varying levels of AI proficiency, different levels of institutional support, and diverse student populations across various course contexts. Regarding research methods, future studies should consider employing randomized controlled designs involving both teachers and students to obtain more valid and generalizable results. By doing this, we can better assess how broadly these findings apply and whether similar outcomes emerge beyond early adopter settings. Finally, this study only examined how AI co-teaching played out in practice over a relatively short period. Future research should therefore focus on its long-term effects on students' learning outcomes, the development of AI literacy, and the evolving roles of AI co-teachers and human instructors.

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APPENDIX

APPENDIX 1-TABLE A1: NORMAL DISTRIBUTION & Z-SCORES WITH GOOGLE NOTEBOOKLM ASSIGNMENT

Section	Details
Goal	Use Google NotebookLM to explore how Z-scores, the Empirical Rule, and the Normal Distribution help make sense of data. Students will practice solving problems, explaining concepts clearly, and connecting statistics to real-life situations.
Tool	Google NotebookLM https://notebooklm.google/
Part 1: Research with NotebookLM	Upload at least one set of class slides, textbook notes, or an article. Use NotebookLM to: • Define the normal distribution and its bell curve shape • Explain Z-scores as a way to standardize and compare data • Summarize the Empirical Rule (68–95–99.7 Rule) • Identify real-world examples (e.g., test scores, heights, manufacturing quality)
Part 2: Report Format	Written Report (Required): 2–3 pages, narrative style Optional: • Audio Overview (3–5 minutes, podcast-style) • Video Overview (3–5 minutes, with narration and visuals)
Part 3: Storytelling Elements	• Begin with a relatable hook • Introduce the normal curve as a character or metaphor • Show how Z-scores place individuals on the curve • Use the Empirical Rule to explain probabilities in everyday terms • Conclude with why these ideas matter in real-world decision-making
Part 4: Reflection (Required)	Length: 150–250 words • Concept: Understanding of normal distribution, Z-scores, and Empirical Rule • Procedure: How calculations helped understanding • Application: Real-world relevance • Beyond the Assignment: Learning growth, AI use, confidence, decision-making
Part 5: Submission Requirements	• Upload report to Canvas • Include screenshots of AI work • Reflection as a separate final section • Upload audio/video files if used
AI Ethics Reminder	Students must reflect on how AI was used and demonstrate understanding. Copying AI output is not permitted.

APPENDIX 2-TABLE A1: EXAMPLE OF A CODED SUMMARY MATRIX -Z SCORE AND NORMAL DISTRIBUTION ASSIGNMENT

Theme	Codes	Illustrative Quotes	Interpretation
AI-enhanced Conceptual Understanding	Understanding normal distribution & bell-curve shape	"The story made the normal distribution feel like a bell-shaped mountain—most values cluster at the peak." "I would have never imagined that AI could breakdown such concepts into a simple	AI metaphors improved conceptual clarity and supported deeper understanding.

Theme	Codes	Illustrative Quotes	Interpretation
	Storytelling as a Learning Mechanism	story. This can be used to learn and understand other areas outside of quantitative analysis as well. ”	Students recognize AI’s ability to simplify complex concepts through storytelling
AI-guided Procedural Learning	Step-by-step AI guidance	“NotebookLM walked me through the steps so I understood every part of the calculation.”	AI scaffolding supports procedural mastery.
	Interactive AI support	“Doing a couple calculations out on my own helped me understand how these problems are presented in real-life settings, and how to use and understand formulas. The AI tools I was provided offered an interactive, interesting way to look into these details and learn more information”	Students using hands-on calculations and AI support to understand formulas and real-world applications.
	Step-by-step calculation with active inquiry with AI	“The way I did those calculations and those steps did help me understand the probability was by asking the notebook the specific questions, and understanding what the answers of those questions did entail.”	using AI to ask targeted questions while working through calculations to clarify steps and deepen understanding.
AI-assisted Application & Transfer	Real-world integration Using AI to bridge classroom & real world	“Beyond theory, I saw how these tools apply to test scores, health data, and even quality control in manufacturing. This assignment also encouraged me to use AI responsibly as a learner” “Getting a real-life example of the empirical rule really helped me understand it more thoroughly and now I think I could relate to the real-world using my own examples.” “As I was doing this assignment, I found it interesting how the empirical rule was used in a real-world setting.”	Students map statistical tools into practical scenarios. AI enhances real-world relevance of statistical skills.
Meta-Learning & Reflection	Monitoring understanding Awareness of learning strategies Responsible AI use AI as a partner	“Using AI tools like NotebookLM was helpful for summarizing information and gathering ideas but reflecting and rewriting in my own words was important for deeper understanding.” “I realized that I learn best when I can get math theories connected to reality.” “Using AI tools like NotebookLM helped guide my thinking, but I had to do the critical thinking myself.” “This did end up reinforcing the responsible use of AI as an aid rather than a substitute for my work.” “I also realized that AI can be a partner in research responsibly, as long as I combine them with my own critical thinking.”	AI-assisted summarization with self-driven understanding Students reflect on preferred learning strategies. Students demonstrate ethical and reflective AI use.

APPENDIX 2-TABLE A2: RESULTS: NORMAL DISTRIBUTION, Z-SCORE, AND EMPIRICAL RULE ASSIGNMENT

Research Question	Coded Theme	Sub-Themes	Example Codes	Representative Excerpt
RQ1: How does AI-assisted guidance within the co-teaching framework help students formulate conceptual understanding of statistical concepts?	Conceptual Understanding	1. Clarifying key concepts such as Z score and normal distribution 2. Visual or story-based learning via AI 3. Shift from Memorization to Meaning	Z score, mean, standard deviation, bell-shaped curve and empirical rule, conceptual clarity visualization, storytelling, story memorization, memorize, shift, meaning, understanding	"I feel that the AI helped me understand these concepts further." "I do end up working best by alternating AI-assisted synthesis with hands-on calculation and visualization" "The storytelling approach made it easier for me to connect with the material." "It made probability feel a lot more real and not just something you memorize for a test."
RQ2: How does AI-supported co-teaching assist students in procedural learning and fluency?	Procedural Learning	1. Step-by-Step Scaffolding 2. Confidence and Fluency in Computation	Z-score computation, guided steps Confidence, problem solving	"The AI walked me through every step until it clicked." "I feel more confident seeing statistics not as just formulas, but as a toolkit for making sense of the world" "With the help of AI tools like NotebookLM, my problem-solving skills become much better and faster."
RQ3: How do students transfer AI-supported statistical learning to real-world scenarios?	Application & Transfer	1.Connecting Statistics to Everyday Decisions 2. Cross-Domain Transfer	Real-world connection, relevance, fairness, decision-making	"It is easier for me to grasp concepts when they are explained using examples that can relate to everyday life."
RQ4: How does AI co-teaching contribute to the development of students' AI literacy, confidence, and reflective learning practices?	Meta-Learning & Reflection Collaborative Learning Triad	1. Self-Regulated and Reflective Learning 2. AI as a Co-Learning Partner 3. Responsible and Critical AI Literacy 4. Human-AI Partnership	Reflection, confidence, curiosity, AI ethics, self-awareness AI-Human Collaboration	"AI can be a great tool for learning as long as you're using it to understand and not just copy and paste answers." "It felt like learning with both a teacher and a smart study buddy guiding me through different parts of the lesson."

APPENDIX 2-TABLE A3. EXAMPLE OF A CODED SUMMARY MATRIX – SIMPLE LINEAR REGRESSION ASSIGNMENT

Theme	Codes	Illustrative Quotes	Interpretation
Conceptual Understanding	Meaning of slope and intercept; relationship between variables; model fit (R^2)	"Using Google NotebookLM made the process interactive. I asked questions in plain English and received clear explanations, which helped me connect formulas to meaning." "NotebookLM simplifies our understanding of the R^2 and slope concept."	Students moved from memorizing formulas to explaining the meaning of regression coefficients and model relationships.
Procedural Learning	Step-by-step AI guidance; Excel verification; checking errors; following calculation sequence	"The AI walked me through each step and I used it to double-check my Excel answers." "The experience has taught me how to evaluate information, for example critiquing and building on to what AI provides."	AI-assisted scaffolding strengthened students' procedural accuracy and confidence in solving SLR problems.
Application & Transfer	Real-world examples (sales prediction, grades vs. study hours, health data); interpreting outputs for decision making	"I used regression to see how advertising affects sales — it made the math feel useful." "I also discovered how useful regression can be outside the classroom. It can help teachers understand student performance, businesses forecast trends, or healthcare professionals predict outcomes."	Students connected regression to practical contexts, showing applied reasoning and transfer of statistical thinking.
Meta-Learning & Reflection	Confidence; curiosity; reflection on learning process; awareness of AI's role in learning	"I felt more confident because NotebookLM explained why each step was important." "Using AI tools like NotebookLM helped me structure my ideas, clarify confusing concepts, and make the explanation more engaging. I now feel more confident not just calculating regression, but also communicating it in simple, clear language."	AI co-teaching promoted reflective thinking and self-awareness, helping students recognize effective learning strategies.

APPENDIX 2-TABLE A4: RESULTS: SIMPLE LINEAR REGRESSION ASSIGNMENT

Research Question	Theme	Sub-Themes	Example Codes	Representative Excerpts
RQ1: How does AI-assisted guidance within the co-teaching framework help students formulate conceptual	Conceptual Understanding of Regression	• Clarifying key concepts such as slope, intercept, and R^2 • Visual or story-based learning via AI • Shift from memorization	AI explained slope/intercept in simple terms; understood R^2 as measure of fit. Storytelling and visualization	"Using NotebookLM helped me clarify definitions and structure my thoughts" "Regression isn't just about math—it's about telling a story with data." " Using NotebookLM helped me visualize the data (video) and clearly understand the regression line."

understanding of statistical concepts?		to reasoning		"Before, I just memorized formulas; now I can explain why the regression line works that way."
RQ2: How does AI-supported co-teaching assist students in procedural learning and fluency?	Procedural Mastery and Confidence AI Scaffolding and Guided Reasoning	• Step-by-step learning through AI feedback • Validation of calculations AI hints for each procedural step Using AI as a "coach" or "tutor"	AI guided slope/intercept calculation; verified my Excel results; checked AI accuracy; confidence in interpreting results AI scaffolded my approach; followed AI's logic; AI summarized steps; used AI as procedural coach	"With NotebookLM, I didn't just get the answer—I understood each step, and that made me more confident." "The experience has taught me how to evaluate information, for example critiquing and building on to what AI provides" "NotebookLM helped me follow the logic of each step instead of guessing the formula." "I also realized that AI can be a partner in research responsibly"
RQ3: How do students transfer AI-supported statistical learning to real-world scenarios?	Application and Real-World Integration	• Connecting regression to test scores, marketing, health outcomes • Translating statistical results into practical meaning • Seeing math in context	study grades; advertising vs. sales; health data interpretation. link between data and decision-making	"I also discovered how useful regression can be outside the classroom. It can help teachers understand student performance, businesses forecast trends, or healthcare professionals predict outcomes." *"*Johnny realized that the hotter the weather, the more cups of lemonade he sold*."* *"*Crafting the storytelling narrative required a much deeper grasp than mere memorization; I had to achieve true comprehension to make the concepts relatable. It sharpened my ability to distill complex information into its most essential parts*."*

	Knowledge Transfer and Lifelong Application	• Applying statistical thinking to daily life • Using reasoning for media or workplace data • Recognizing generalizability of regression logic	used regression reasoning in daily life; interpreted trends in media; extended data literacy beyond class	"Now I think in patterns—AI made me realize regression applies everywhere." "Regression is useful in real life because it shows how variables relate and helps predict results. For example, understanding how study hours affect scores can help improve learning strategies." "I learned that regression is a good way to predict things based on relationships between variables."
RQ4: How does AI co-teaching contribute to the development of students' metacognitive awareness, reflection and AI literacy?	Metacognition and Self-Regulated Learning	• Evaluating AI feedback accuracy • Self-questioning and progress tracking • Reflecting on understanding gaps • Developing autonomous learning habits	checked AI for errors; recognized misunderstanding; used AI to reflect on progress; developed self-learning strategy	"I learned to question AI explanations and verify results—it made me more reflective." " I didn't copy the answer but used AI to truly understand the topic" "It felt like learning with both a teacher and a smart study buddy guiding me through different parts of the lesson."
	AI Literacy, Confidence, and Ethical Awareness	• Responsible and critical use of AI • Understanding AI limitations • Ethical awareness of AI as a tool	AI as co-teacher not replacement; used AI responsibly; reflected on ethical learning; recognized limits of AI	"I used AI responsibly as a tutor to clarify ideas but kept the explanations in my own words." "It also taught me to use AI tools responsibly by verifying their suggestions and understanding the methods behind them." "One of the skills I gained through this assignment was in understanding the limitations of AI"