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The Use and Impact of AI on Students' Achievement in Mathematics Courses

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ABSTRACT — Artificial intelligence (AI) programs are now being widely used and their impact has been proven to enhance student achievement. The aim of the study is to observe the use and impact of AI on students' achievement in Mathematics and Statistics courses. The population in this study was all students of the Faculty of Information Technology, Universitas Advent Indonesia, taking or have taken Mathematics and Statistics courses from the lecturer (the first author of this paper), totalling 191 students. The study showed that 48% of students admitted that AI could improve their academic performance, while around 44% of students became more active and satisfied in learning mathematics and statistics. However, the students' achievements were not permanent, as 71.3% of students admitted that their achievements were not lasting. The results indicate, based on experimental research comparing the results of quizzes (which were discussed after the tests) with mid or final exam results (derived from quizzes), that there was no improvement in test scores and even no significant impact (and correlation) between quiz results and mid or final exams. In fact, the majority (60.6%) of students were unsure, disagreed, or even strongly disagreed whether the impact of AI is more positive than negative on their learning. The results of this study suggest that AI is best used as a learning tool not merely to achieve learning outcomes, but assist deep learning to improve critical thinking.

KEYWORDS — AI, ChatGPT, Impact of AI, Academic Achievement, Linear Algebra, Discrete Mathematics, Statistics and Probability.

I. INTRODUCTION

As the COVID-19 pandemic has subsided and no longer poses the same level of concern, society has entered the new normal era. The COVID-19 epidemic, began in early 2020, has caused in millions deaths and affected educational systems in both positive and negative ways. Prior to the COVID-19 pandemic, the majority of instruction at Indonesian universities, notably Universitas Advent Indonesia (UNAI), was done offline. However, the COVID-19 pandemic compelled a shift to online education. Online classroom management systems, like Moodle, are utilized in conjunction to online learning models. These systems deliver assignments and tests online. Both students and educational institutions may be impacted by this abrupt shift in learning styles.

Previous research on the effect of the COVID-19 pandemic on academic performance has reported an improvement in student accomplishment at UNAI [1]. Based on student opinions and assessments, research examining the impact of COVID-19 epidemic on instructor performance at UNAI [2] likewise revealed a modest, though not statistically significant improvement, in lecturer performance. A study on the effect of the COVID-19 pandemic on UNAI institutions' performance was also carried out, and the results showed an increase during the pandemic, particularly in the areas of finance, professor publications, and university rankings [3], [4].

Aside from implementing management and learning models due to the COVID-19 epidemic, artificial intelligence (AI) applications like ChatGPT have been utilized recently. The use of AI, such as ChatGPT, in learning can transform the traditional learning environment into a different learning environment, offering self-directed, effective, and creative learning, thereby enhancing teaching effectiveness and student performance. Since they can enhance learning outcomes, customize instruction, and address individual learning needs, a number of AI-driven learning technologies, including intelligent tutoring systems, adaptive learning platforms, and automated feedback tools, have been embraced by both educators and students in the modern learning process. Mathematics, as a subject that often presents significant challenges for students due to its abstract, logical, and cumulative nature, can be made easier by adopting AI technology.

With the increasing implementation of AI in the field of education, numerous studies are needed to examine appropriate methods for integrating AI into learning so that students' learning experience and understanding of AI use are profound and permanent. While some investigation have been done to examine how the use of AI affects different subjects' learning demands, there has not been much research, specifically focused on Mathematics courses, to see whether the achievements attained by students are permanent. Understanding the impact of AI on mathematics learning is important for educators, school policymakers, and AI developers to design deep learning experiences with AI that can enhance students' critical thinking, besides academic achivements (for example grades).

By assessing how AI is used and affects students' mathematical ability as well as how students see its use and effects on their learning outcomes, this study seeks to close this gap. By analyzing students' learning data from daily quizzes, mid-term exams, and final exams and combining these data with students' perceptions of the use and impact of AI on their study results, a comprehensive understanding on how AI may

improve learning outcomes in mathematics can be achieved. The findings obtained have the potential to inform evidence-based practices and guide future innovations in AI-assisted learning.

This research is considered to provide a unique contribution compared to previous studies, as it uses two research methodologies, namely experimental and descriptive research. Comparing learning outcomes between the experimental group that utilizes AI and the control group tat does not is the methodology commonly used to observe how AI usage affects learning outcomes. In this study, there is no group division; all students are allowed to use AI during daily tests (quizzes), midterms, and final examinations. Then, this study examines if the students' achievements remain consistent when the same quiz questions are given during the mid or final examinations, and whether the experiment's findings align with how students' perception of AI influence on their education.

II. AI IMPACT ON LEARNING

Since its inception, ChatGPT has been marketed as being very beneficial in a number of domains, including education. Nonetheless, there is a lot of discussion among educators about its advantages and disadvantages. As of right now, there is no set educational policy pertaining to the use of AI chatbots. While some have advocated for a ban, others contend that this technology's development is unstoppable and should be handled responsibly.

Adoption of AI chatbots, such as ChatGPT, at higher education institutions can benefit a range of academic activities, including admissions, since they can speed up enrollment with tailored strategies to match the needs of each individual student. AI chatbots support student services by helping with counseling, finance, and customized scheduling. Additionally, by developing interactive learning environments that improve students' comprehension of the material and provide them with tailored feedback, ChatGPT can enhance instruction. Lastly, AI chatbots can increase student retention by providing customized advice and assistance [5].

AI chatbots have been found to offer significant support to students by offering course material summaries, study material recommendations, and information regarding assessment requirements [6]. According to another study on the use of virtual teaching aids in higher education, students who used chatbots outperformed those who interacted with the course teachers in terms of academic performance [7]. Research on the effects of chatbots on immersive virtual English learning environments revealed that this technology enhanced university students' ability to negotiate [8], improved their perception of the learning environment [9], and increased a number of knowledge acquisition measures [10].

Present study provides a useful starting point for comprehending the advantages of chatbots in research. ChatGPT has influenced academic research, thereby improving writing quality and making research more understandable to non-expert readers. It may, however, also result in challenges with authorship, responsibility, authenticity, and the trustworthiness of the text that is produced [11].

The use of AI chatbots to gather qualitative data for research has also been covered in several papers. For example, a prototype of two chatbots—one with and one without active listening capabilities—has been created by researchers [12]. After comparing the two chatbots' performance with 206 participants, it is concluded that the study provides practical methods for developing interview chatbots, can gather data on human behavior and physiology when interacting with chatbot-like technology, compare the qualitative data collected by automated virtual interviewers and human interviewers, collect ethnographic data for analysis, and generate data of higher quality than web-based surveys.

AI chatbots are considered to have the potential to increase student retention. Chatbots improve student achievement outcomes in one study for a computer-generated conversational agent-aided evaluation system: academic achievement, confidence, learning mindset, enthusiasm, and heightened learner participation in the educational process [13], give students access to standardized academic information, such as course content [14], and practice questions and exercises [15]. Additionally, chatbots are used to provide academic and administrative services [16]; teach computer programming concepts [17]; provide information about campus locations [18]; enhance communication, learning, and productivity; increase the effectiveness of teaching assistance, and reduce interaction ambiguity [19]. Furthermore, it is hypothesized that the use of AI in academia will enhance operational governance in both the academic and nonacademic domains [20].

In addition to all previously listed benefits of using AI chatbots, research also highlights possible drawbacks. The risks of implementing AI chatbots in higher education include the following: potential misinformation, the reinforcement of underlying biases through data training and related privacy [21], increased information asymmetry [22], illegal use, stereotyping, inaccurate information, unexpected outcomes, cognitive bias, decreased human engagement, restricted accessibility, and unethical data collection [1]. Additionally, it is cautioned about the potential dangers of leveraging social data, such as human bias, to train AI systems, which may lead to biased decision-making [23]. Adopting AI-based technologies in academia carries risks, such as the potential maintenance of existing systemic bias and discrimination, the continuation of unfairness for students from marginalized and historically disadvantaged groups, and the exacerbation of racist, sexist, xenophobic, and other forms of prejudice and injustice. The authors also discuss how AI-based systems might follow and monitor students' ideas and thoughts, potentially endangering students' privacy [24].

In terms of engagement and learning outcomes, AI chatbots have a detrimental effect on learning when they replace human interaction. When foreign language learners engage with chatbots instead of human partners, their task interest significantly decreases, according to a study on the long-term effects of chatbots on task and course interest [25]. AI chatbots should be regulated in some way to prevent the spread of false information because of the dangers of a technology that can write like a human and respond to a variety of questions with high levels of fluency and coherence. One of these threats is disseminating false information or pretending to be someone else [26].

Given the above-mentioned benefits and concerns of implementing AI chatbots in the classroom, there is still a need for educators to be more actively involved in this study, especially in the particular courses that these educators teach. This can be taken into account while creating certain policies and instructional methodologies that incorporate AI chatbots. In order to ascertain the effects of implementing AI chatbots in

mathematics lectures, the author carried out a particular study in Mathematics courses. This study sought to ascertain whether the use of AI had an effect on students' learning and performance and and whether any positive impact on mathematics achievement remaines over time.

III. METHODOLOGY

Two forms of research or data collection were carried out in order to meet the goals of the study. The first involved a descriptive study of students' perceptions of the use of AI algorithms in learning statistics and mathematics. The percentage of students utilizing AI programs to complete assignments and tests was determined using this perception data. The second goal was to determine students' pereceptions of the conveniences they experienced while utilizing AI in their learning. The third goal was to determine students' perecptions of the impact of AI on learning results, engagement, and satisfaction. The fourth goal wss to assess how dependent students feel on AI for learning, assignments, and tests. The second form was an experimental investigation sought to determine whether student accomplishments brought by the application of AI remained over time.

A. POPULATION AND SAMPEL

The study population comprised all 191 students enrolled in the author's five courses during the even semester of 2023–2024. The number of students enrolled in the five subjects is presentetd in Table I.

B. STUDENTS' PERCEPTIONS ON THE USE AND IMPACT OF AI

A survey containing 12 questions was created to students' perception of the use and influence of AI algorithms in math and statistics education. The questions are presented in Table II. Likert scale response options are provided for the twelve questions [27]: 1 indicates strongly disagree (SD), 2 indicates disagree (D), 3 indicates neutral or unsure (N/US), 4 indicates agree (A), and 5 indicates strongly agree (SA). In addition to the 12 questions, questions related to gender, study program, and cohort/admission year were also included, as this information may be required in cross-tabulation analysis.

To prevent submission duplication, the survey was made available via a Google Form that students could access using their email addresses. Through the class WhatsApp group, the researcher shared the the Google Form link with students who had previously taken the researcher's Mathematics and Statistics courses. Students were given three days to finish the form, and thos who had not done so within the deadline were encouraged to submit their response. Daily updates on the temporary number of respondents were also supplied. Following the three-day deadline, the Google Form was closed. The data were downloaded and analyzed in accordance with the study's goals.

In order to ascertain whether the questionnaire could be used, validity and reliability tests were performed prior to the statistical analysis. The validity test's results that indicated all questions were valid at a significance level of 99%, showing a Pearson correlation coefficient between the question items of 0.990. According to the reliability test, the questionnaire's question items were dependable because each question's Cronbach's alpha value was over 0.7 and the total score was 0.79, which is higher than 0.6. Consequently, all questions were deemed appropriate for use in this study.

TABLE I
NUMBER POPULATION AND SAMPLE

Course	Class	Number
Statistics and Probability	Informatics Engineering (IE)	51
Statistics and Probability	Information Systems (IS)	25
Discrete Mathematics	Informatics Engineering (IE)	35
Discrete Structure	Information Systems (IS)	29
Linier Algebra	Informatics Engineering (IE)	51
	Total	191

TABLE II
ITEMS OF THE QUESTIONNAIRE TO ASSESS STUDENTS' PERCEPTIONS REGARDING THE IMPACT OF AI

Code	Questions
P1	I am happy with the learning of Mathematics and statistics from the relevant lecturer.
P2	I use ChatGPT or other AI programs in learning Mathematics and Statistics (doing assignments, exams, group discussions, etc.)
P3	I find it easier to work on Mathematics and Statistics class assignments using ChatGPT or other AI programs.
P4	I feel increasingly able to understand learning Mathematics and Statistics more easily with the use of ChatGPT or other AI programs.
P5	I feel that my achievement in the results (grades) of Mathematics and Statistics learning is increasingly improving by using ChatGPT or other AI programs during the exam.
P6	My understanding of learning Mathematics and Statistics becomes more permanent (long-lasting) when using ChatGPT or other AI programs as learning aids.
P7	I am becoming increasingly dependent on the use of ChatGPT or other AI programs in studying, completing assignments, and taking Math or Statistics exams, and without using ChatGPT or other AI programs, I feel less confident.
P9	My satisfaction in learning for both Mathematics and Statistics classes increases when using ChatGPT or other AI programs in the learning process.
P8	My motivation or interest in learning for Math and Statistics classes increases when using ChatGPT or other AI programs in learning.
P10	I am becoming more active in studying (both alone and with classmates) for Math and Statistics classes when using ChatGPT or other AI programs in learning.
P11	ChatGPT or other AI programs can be relied upon for learning Mathematics and Statistics.
P12	The use of ChatGPT or other AI in learning Mathematics and Statistics has a more positive impact than negative for students.

According to study programs, 104 students completed the questionnaire: 67 were male (64.4%) and 37 were female (35.6%). Of these students, 40 students (38.5%) were Information System (IS) students and 64 students (61.5%) were Computer Engineering students. In term of cohort distribution, 32 students (30.8%) were from 2024 intake, 41 students (39.5%) were from 2023 intake, 19 students (18.3%) were from 2020 intake, and 12 students (11.5%) were from 2021 intake. The aforementioned statistics are nearly proportionate by batch, academic program, and gender.

C. EXPERIMENTAL RESEARCH ON WHETHER STUDENTS' ACHIEVEMENTS ARE PERMANENT

An experiment was conducted by comparing daily quiz results with midterm or final test results to determine whether the students' learning accomplishments remained. The average quiz, midterm exam, and final exam scores were among the data gathered for this study. This study investigated how average quiz scores prior to the midterm affected midterm scores and how average quiz scores following the midterm test affected final scores. The average quiz score prior to the midterm was the mean of all quizzes taken prior to the midterm test, and the mean score following the midterm was the sum of all quizzes taken after the midterm. Five quizzes were administered prior to the midterm, and five more were administered following the midterm.

The quiz questions pertain to the lecture content that was covered at the previous week's meeting. The test was administered prior to the start of class. Depending on the difficulty of the questions, each exam must be comlpleted in 10 to 15 minutes. There were five to ten true/false, multiple-choices, and/or matching questions on each quiz. The UNAI Moodle was used to prepare and administer the online midterm exam.

All of the content covered before the midterm was connected to the material on the midterm exam. Unlike quizzes, the midterm test was administered offline, with students responding to essays or calculations and explanations. The format and nature of the quiz questions following the midterm exam were identical to those used before the midterm. In contrast to the midterm exam, the final exam (end of semester) was administered online through Moodle and consisted of true/false, multiple choice, and/or matching questions, which were comparable to those found in quizzes. All of the subjects taught after the midterm were included in the materials covered in the final exam. Since there was no difference in learning outcomes between essays and multiple-choice, true/false, and matching answers, the final exam questions were not answered using essays.

D. HYPOTHESIS TESTING AND ANALYSIS

Using the average test (t-test), the average scores of quizzes prior to the midterm and midterm exam were statistically analyzed to see if there was a difference between the average scores prior to the midterm and the midterm exam scores. The hypothesis is:

Ho: There is no difference between the average quiz scores and midterm or final scores

Ha: There is a difference between the average quiz scores and midterm or final scores

The testing criterion is: Ho is rejected if the p-value < alpha (0.05).

After the average test, the correlation coefficient was also calculated to see the strength/weakness of the relationship between the average quiz scores and the midterm or final exam scores. The correlation coefficient range and its interpretation is given in Table III [28].

A linear regression test was used in the following analysis to see whether the average quiz score significantly affected the midterm or final scores. With x being the average quiz score and y representing the midterm or final score, the linear regression equation is $y = ax + b$. The hypothesis for the regression test is:

TABLE III
CORRELATION COEFFICIENT AND INTERPRETATION

Correlation Coefficient (R)	Interpretation
0.00 – 0.20	Very weak
0.21 – 0.40	Weak
0.41 – 0.70	Moderate
0.71 – 0.90	Strong
0.91 – 1.00	Very strong

Ho: There is no significant influence of the average quiz score on the midterm or final scores.

Ha: There is a significant influence of the average quiz score on the midterm or final scores.

The testing criteria is: Ho is rejected if the p-value < alpha (0.05).

IV. RESULTS AND DISCUSSION

A. RESULTS

1) STUDENTS' PERCEPTIONS REGARDING THE USE AND IMPACT OF AI

Students' perceptions of AI use and its effects on learning outcomes in mathematics and statistics make up the first section of the results. The results of the students' perception survey are shown in Table IV. As can be observed from Table IV, the frequency data presentation order does not correspond to the question sequence on the Google Form. For ease of frequency analysis, the Likert scale responses were split into only three portions: agree (A), strongly agree (SA), neutral or unsure (N/US), and strongly disagree (SD) and disagree (D). Based on the percentage, the survey results can be divided into three categories. First, as in questions P1, P2, P3, and P4, the percentage is greater than 50% (majority). Second, as in questions P5, P7, P9, P10, and P11, the percentage is higher than the others but not a majority (<=50%). Third, as in questions P6, P8, and P12, the percentage is neutral or uncertain (N/RR) and higher than the other groups.

Table IV shows that 68.3% of students (data P1) agreed or strongly agreed that they enjoy learning statistics and mathematics. This may be because AI can help them with their studies, assignments, and tests. However, only 44.2% (data P9) expressed higher satisfaction with learning statistics and mathematics as a result of AI, indicating that not all satisfaction is driven by AI.

Students at the Faculty of Information Technology utilized AI to learn statistics and mathematics, complete their assignments, and even locate answers on tests. AI was utilized in tests, and 61.5% of students used ChatGPT or similar tools for both individual and group work. More than half of students believe that ChatGPT or other AI tools can help them with homework and test-taking. Furthermore, 66.3% of students agreed or strongly agreed that the use of AI facilitates students to complete their assignments. Then, 54.8% of students agreed that ChatGPT could assist students to better understand the material, even for subjects that could be easier to learn in class.

Although fewer than 50% students reported that ChatGPT and other AI programs affected learning outcomes, 44.3% of students acknowledged that ChatGPT encouraged them to be more active in their education, and 48.0% of students believed that the use of AI programs improved their grades. Additionally, 44.2% of students reported that they were more satisfied with their learning in mathematics and statistics,

TABLE IV
PERCEPTION QUESTIONS ABOUT THE IMPACT AND USE OF AI

Code	Questions	SD/D	N/US	SA/A
	SA/A majority (> 50%)			
P1	I am happy with the learning of Mathematics and statistics from the relevant lecturer.	4.8	26.9	68.3
P2	I use ChatGPT or other AI programs in learning Mathematics and Statistics (doing assignments, exams, group discussions, etc.)	5.8	32.7	61.5
P3	I find it easier to work on Mathematics and Statistics class assignments using ChatGPT or other AI programs.	3.9	29.8	66.3
P4	I feel increasingly able to understand learning Mathematics and Statistics more easily with the use of ChatGPT or other AI programs.	11.5	33.7	54.8
	SA/A dominant (<=50%)			
P5	I feel that my achievement in the results (grades) of Mathematics and Statistics learning is increasingly improving by using ChatGPT or other AI programs during the exam.	11.6	40.4	48.0
P7	I am becoming increasingly dependent on the use of ChatGPT or other AI programs in studying, completing assignments, and taking Math or Statistics exams, and without using ChatGPT or other AI programs, I feel less confident.	21.1	36.5	42.3
P9	My satisfaction in learning for both Mathematics and Statistics classes increases when using ChatGPT or other AI programs in the learning process.	14.5	41.3	44.2
P10	I am becoming more active in studying (both alone and with classmates) for Math and Statistics classes when using ChatGPT or other AI programs in learning.	16.3	39.4	44.3
P11	ChatGPT or other AI programs can be relied upon for learning Mathematics and Statistics.	10.5	40.4	49.1
	N/US dominant			
P6	My understanding of learning Mathematics and Statistics becomes more permanent (long-lasting) when using ChatGPT or other AI programs as learning aids.	30.8	40.4	28.9
P8	My motivation or interest in learning for Math and Statistics classes increases when using ChatGPT or other AI programs in learning.	12.5	47.1	40.4
P12	The use of ChatGPT or other AI in learning Mathematics and Statistics has a more positive impact than negative for students.	14.4	46.2	39.4

42.3% of students reported that they were becoming more and more reliant on AI programs, and 49.1% of students believed that ChatGPT or other AI programs could be trusted for learning mathematics and statistics.

In term of the impact of AI program on the motivation of learning statistics and mathematics, only 40.4% of students agreed or strongly agreed that AI systems might increase their interest and willingness to learn, while 47.1% of students voiced reservations and 12.5% disagreed or strongly disagreed. This suggests that while AI can help students understand statistics and mathematics, it might not always boost their desire and interest in the subject.

In term of students' perception whether AI has more positive than negative effects, 39.4% students agreed or strongly agreed with this statement, 46.2% replied "yes," a4.4% students disagreed or strongly disagreed, resulting in a total of 60.6%. Students are aware of the drawbacks of employing AI in learning, and it is probable that these drawbacks outweigh the benefits, despite the fact that AI systems may aid them in their academic endeavors.

Around 71.2% of students (40.4% were unsure and 30.8% disagreed or strongly disagreed) did not believe that improvements in understanding and learning results were sustained, in contrast to the applications and effects of AI systems in mathematics and statistics teaching. Given that these findings are easily acquired with the use of AI, this finding of this research implies that although students give accurate answers on exams, they may not understand why those answers are correct. This is because these results are obtained without a normal learning process or critical thinking. It is very likely that roughly 71.2% of students will be unable to provide the right answer if AI is not used during the test and the same questions are asked at a different time.

2) INFLUENCE (CORRELATION) OF QUIZ SCORES WITH MIDTERM OR FINAL EXAMINATION

To determine whether quiz results affect midterm or final grades, this experimental study compared average quiz scores with midterm and final scores. If quiz scores have an impact on grades at the middle or end of the semester, there should be a high correlation between the two scores. If regression analysis is used, there should also be a strong correlation between the quiz score variable (x) and the mid or final score (y). This is because the quiz items make up the majority of the items on the midterm or final exams. Furthermore, the quiz items were addressed right away following its administration. The second section of the research findings examines how students view the application and effects of artificial intelligence (AI) in the teaching of statistics and mathematics.

Table V presents the average score parameters, values, correlations, and regressions for IS program students enrolled in the Statistics and Probability courses. The data for quiz 1 represent the average of all quizzes completed by students prior to the midterm exam, while quiz 2 represents the average of all quizzes taken by students following the midterm (the second half of the semester) but prior to the final exam. The final exam questions covered all of the content covered after the midterm, while the midterm questions only pertained to the material covered before to the midterm. The majority of the questions on the midterm and quiz 1 were identical, as are the majority of the questions on the final.

Table V shows that, during the first half of the semester, the average quiz scores were higher than the average midterm test scores; but, for the second half of the semester, the average quiz scores and final scores were essentially equal. Statistical testing with the average test (t-test) validated this finding. The average quiz score and the mid-score had a very weak relationship, and

TABLE V
DATA SCORES, CORRELATIONS, AND REGRESSION FOR STATISTICS AND PROBABILITY COURSE (IS).

Parameter	Quiz1 vs Mid	Quiz2 vs Final
Average score	Quiz1 (51.2) > Mid (44.3)	Quiz2 (43.1) ≈ Final (41.2)
Correlation (coefficient)	Very weak (R = 0.05)	Weak (R = 0.35)
Regression (p-value)	No influence (0.81)	No influence (0.17)

did the average quiz score and the final score. Regression analysis revealed that neither quiz 1's average nor quiz 2's average had a significant impact on the final score. These findings suggest that there is no assurance that students will obtain high grades on the midterm or final exam, even if they perform well on the quiz. Although a student properly answers a question, they may forget the answer if an identical question is asked again during the midterm or final exam, because the answer was likely generated with the help of ChatGPT or other AI algorithms.

Table VI displays the average quiz, midterm, and final scores as well as the findings of statistical analyses of average tests, correlations, and influence tests of the Statistics and Probability course in the Informatics Engineering (IE) Study Program. The average score on quiz 1 was higher than the midterm score on the average statistical test, and the average score on quiz 2 was higher than the final score. According to the correlation analysis, there was a very poor association between quiz 1 and the midterm and a weak correlation between quiz 2 and the final. It is evident from the regression analysis that quiz 1 had no discernible impact on the midterm and quiz 2.

A comparison of data from Computer Engineering and IS Study Program for the same course showed that Computer Engineering students performed better than IS students. However, the analytical results for other parameters (correlation and regression) showed that quiz scores had no effect on midterm or final scores and there was a weak association between quiz scores and these assessments. The higher midterm or final scores achieved by IE students may attributed ti the difference in fundamental abilities, with IE students generally outperforming IS. This is unrelated to correlation and regression parameters.

Table VII presents the average score parameters, values, correlations, and regression for the Computer Science course Discrete Mathematics (IE). In the first and second half of the semester, the average quiz score was higher than the average midterm score. There was a moderate link between the quiz results and the mid and final scores. According to the results of the regression analysis, the average quiz score significantly affected both the midterm and final scores.

Table VIII lists the average score parameters, values, correlations, and regressions for Discrete Structures course in IS Study Program. In the first and second half of the semester, the average quiz scores were higher than the average midterm or final scores. There was a moderate link between the quiz results and the mid and final scores. Additionally, the regression analysis demonstrated that neither the midterm nor final scores were significantly impacted by the average quiz scores.

TABLE VI
DATA SCORES, CORRELATIONS, AND REGRESSION FOR STATISTICS AND PROBABILITY COURSE (IE)

Parameter	Quiz1 vs Mid	Quiz2 vs Final
Average score	Quiz1 (67.4) > Mid (63.2)	Quiz2 (52.5) > Final (44.1)
Correlation (coefficient)	Very weak (R = 0.14)	Weak (R = 0.23)
Regression (p-value)	No influence (0.32)	No influence (0.11)

TABLE VII
DATA SCORES, CORRELATIONS, AND REGRESSION FOR DISCRETE MATHEMATICS (IE)

Parameter	Quiz1 vs Mid	Quiz2 vs Final
Average score	Quiz1 (59.0) < Mid (61.6)	Quiz2 (67.1) > Final (55.0)
Correlation (coefficient)	Weak (R = 0.28)	Weak (R = 0.25)
Regression (p-value)	No influence (0.10)	No influence (0.09)

TABLE VIII
DATA SCORES, CORRELATIONS, AND REGRESSION FOR DISCRETE STRUCTURE (IS)

Parameter	Quiz1 vs Mid	Quiz2 vs Final
Average score	Quiz1 (62.3) > Mid (48.4)	Quiz2 (78.4) > Final (65.3)
Correlation (coefficient)	Weak (0.37)	Very weak (R= 0.15)
Regression (p-value)	No influence (0.075)	No influence (0.108)

Table IX presents the average score parameters, values, associations, and regression students in the IE enrolled in the Linear Algebra course. In the IE Study Program, approximately 98% of student taking the Linear Algebra course were identical to those enrolled in the Statistics and Probability courses. The average quiz score was higher than the average midterm or final exam score, as the Table IX illustrates. Even though there was a moderate association between final exam scores and quiz scores, quiz and mid-exam scores had a weak correlation. According to the regression study, the average quiz score had no discernible impact on midterm or final test performance.

B. DISCUSSION

Typically, the average quiz score was higher than the average midterm or final score, or at least equal to it. Since the materials given in the midterm or final exams was the same as those given in prior quizzes (roughly 50% of the material being precisely the same and the remaining 50% having modest alterations in both questions and answers), it was initially assumed that the midterm or final results would be higher than the quiz scores. Additionally, every question on the test was covered in class right after it was finished. The quiz questions were accessible online through Moodle UNAI, and students were not permitted to take notes or copy them, nor may they be reviewed at any other time.

Students forgot previously discussed quiz questions if their midterm or final exam grades were not higher (or even lower) than their quiz scores. Many students were unable to provide an explanation for their correct answers, thus certain students who achieved a score of 100 were sampled and asked to explain their answers when the exam questions were revisited in class just after it concluded. They even joked that they had clicked

TABLE IX
DATA SCORES, CORRELATIONS, AND REGRESSION FOR LINEAR ALGEBRA (IE)

Parameter	Quiz1 vs Mid	Quiz2 vs Final
Average score	Quiz1 (71.9) > Mid (56.7)	Quiz2 (77.4) > Final (58.2)
Correlation (coefficient)	Very weak (R = 0.14)	Very weak (R = 0.17)
Regression (p-value)	No influence (0.07)	No influence (0.08)

the wrong button by accident or that their responses depended on chance. Only a small percentage of students who had accurate answers were able to revise or clarify their responses. In addition to using AI, students were also learning to understand lecture materials and exams so that the critical thinking process functions. According to survey results, roughly 29% of students agreed or even strongly agreed that their understanding was permanent (item p6 of the perception questionnaire).

At first, it was assumed that the high scores achieved by some students were the result of cheating or teamwork. This might occur for quizzes because there werw only five to ten questions, despite the fact that the Moodle system randomly selects the questions. However, it is nearly impossible to do so for midterms or finals because there were between fifty and sixty questions. Because of the large number of questions and the fact that the Moodle system randomly selects them, it is unlikely that students will cooperate on these tests. For many randomized problems, collaboration is extremely unlikely, if not impossible, and the use of AI to help find solutions is becoming increasingly infeasible. This element could be the cause of midterm or final scores that fall short of the mean quiz scores.

In general, midterm or final test scores were not significantly impacted by quiz results. Correlation analysis revealed very weak to moderate associations between quiz scores and midterm or final examination scores. It is clear from these two statistical measures that quiz scores do not accurately represent students' intellectual aptitudes. Despite the fact that quiz questions are addressed right away, students frequently forget the answers and do not remember them for midterm or final exams. According to this fact, students who use ChatGPT or AI technologies during tests frequently forget the answers they were given. Thus, student achievement is determined by how well they use AI/ChatGPT to answer test questions rather than how hard they try to learn the subject being taught or practice problems that were covered in class. As previously mentioned, the midterm exam questions are written in the style of essays, whereas the final exam questions are similar to the quizzes but not essays. Nonetheless, the midterm and final exhibit roughly the same phenomena.

The degree of difficulty of the courses and the students' own desire or interest are the main causes of the variations in grades that students receive. Students studying information technology are generally less interested in auxiliary courses like statistics and mathematics and more interested in courses that directly connect to programming and information technology comprehension. Even yet, the importance of supporting courses in programming and information technology comprehension was stressed to them when they first enrolled as new students.

V. CONCLUSION

Several conclusions may be drawn from the research findings discussed above, including the fact that AI can improve students' comprehension of course materials, facilitate their completion of tasks, and even help them with exam problems. Additionally, AI can be used to help students understand mathematics, become more involved in their studies, raise their grades, and even improve their enjoyement in education. Even though there are a lot of advantages to employing AI, students think that these advantages are not greater than the potential drawbacks. However, the results students receive on tests are not permanent when they employ AI only to earn grades. Students are becoming more and more reliant on artificial intelligence, and they have a propensity to focus solely on results and grades, ignoring the correct procedures to achieve such scores.

According to the study's findings, math teachers should gain a better understanding of the advantages and disadvantages of AI programs in order to create assignments and test questions that are difficult for AI alone to answer. It is essential to create homework assignments and test questions that foster deep learning and critical thinking skills, as well as those that are applicable to real-world scenarios.

CONFLICTS OF INTEREST

Authors declare there is no conflict of interest in this study.

AUTHORS' CONTRIBUTIONS

Conceptualization, Albinur Limbong; data collection, Albinur Limbong and Idauli Simbolon; methodology, Albinur Limbong; data validation and analysis, Albinur Limbong and Idauli Simbolon; writing draft, Albinur Limbong; literature reviewing and editing, Idauli Simbolon; funding, Albinur Limbong and Idauli Simbolon.

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