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The Influence of Using Natural Language Processing (NLP)-Based Generative Artificial Intelligence on 21st Century Skills in Higher Education: A Quantitative Analysis

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ABSTRACT

This study aims to analyze the effect of using natural language processing (NLP)-based generative artificial intelligence on 21st-century teaching skills. This research is quantitative using the simple linear regression analysis method. The research sample consisted of 270 students at Walisongo State Islamic University Semarang. The main focus of this study was to explore the relationship between the use of NLP-based generative AI and four 21st-century skills, namely critical thinking, problem-solving, collaboration, and communication. The results of the statistical analysis showed that the use of this AI had a significant influence on all four skills. Collaboration (Y3) is the skill most influenced by AI with a P-value of 0.000 and a t-count of 4.36, indicating that AI strengthens individuals' ability to cooperate and coordinate in teams. Critical thinking (Y1) ranked second with a P-value of 0.001 and a t-count of 3.47, indicating that AI promotes analytical and evaluative skills. Problem solving (Y2) also showed a significant effect with a P-value of 0.001 and a t-count of 3.41, indicates that AI helps in finding innovative and effective solutions to complex problems. Meanwhile, communication (Y4) was the least influenced skill, with a P-value of 0.005 and a t-count of 2.83, although it remained significant.

KEYWORDS

Natural natural language processing (NLP), Generative artificial intelligence, 21st century skills, Higher Education

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Introduction

Artificial Intelligence (AI) has potential in Indonesian education, making it important to study it in depth. Buddy (2023) reported that there were more than 24 billion Indonesian people visits to the 50 most popular AI tools between September 2022 and August 2023, with an average monthly growth of 236.3 million visits. Indonesia ranks third as the country with the most AI users, contributing 1.4 million visits, only slightly behind India and the Philippines. In addition, according to Indonesia's Deputy Minister of Communication and Information Technology, 22.1 percent of workers in Indonesia from various sectors have implemented AI in their daily work. These figures show that AI adoption in Indonesia is growing rapidly and is increasingly important to people's professional and social lives (Kominfo, 2023). With this significant adoption rate, Indonesia faces the potential, challenges, and impacts of using AI, especially for Generation Z who dominate technology consumption (Chan & Lee, 2023). Understanding how AI can be optimized to meet economic and social needs in Indonesia can provide valuable insights for developing policies and strategies to make the most of this technology.

Although relatively new, education scholars have paid significant attention to the existence of artificial intelligence and its benefits in education. Pavlik John (2023), for example, has successfully observed the positive impact of using Chat GPT as an AI tool to improve the writing skills of doctoral students in Sweden. Meanwhile, Baidoo-Anu David and Leticia Owusu Ansah (2023) have conducted a review of AI research trends from 2020 to 2023, which highlighted the lack of focus on studies measuring the impact of AI on learning independence, including limitations in investigating the impact of AI on the learning process in Islamic-based universities. Other findings revealed by Yang Weipeng (2022) highlighted potential conflicts between students and lecturers, such as privacy issues, changes in power structures, and excessive control that may arise from the impact of AI on meeting learning demands. All of these studies point to the need for further research to deeply understand the impact of AI systems on learning. The field of study that looks at how AI tools affect 21st-century skills is rarely of interest (González Pérez, Laura Icela, and María Soledad, 2022). It is important to help identify any gaps, issues, or barriers that may prevent AI systems from achieving the potential success of 21st-century learning.

It is not wrong to say that the use of artificial intelligence (AI) has a very important role in achieving 21st-century learning skills. This is supported by the research of McDonald Et.al, 2023 which shows that AI can provide innovative solutions in personalizing learning, identifying students' individual needs, and providing customized learning experiences. By applying this technology, educators can create a responsive and engaging learning environment, which enables students to develop critical skills such as problem-solving, creativity, collaboration, and critical thinking (Alhashimi, 2020). Yet little is known about how AI can affect the learning process in Islamic-based

universities. Ismutik predicts that AI can also help lecturers monitor student progress in real time, provide prompt feedback, and customize learning materials according to individual levels of understanding. (Rathore, 2023) More work is needed on how and why the use of AI can help create a generation of students in Islamic universities to face global challenges with relevant skills.

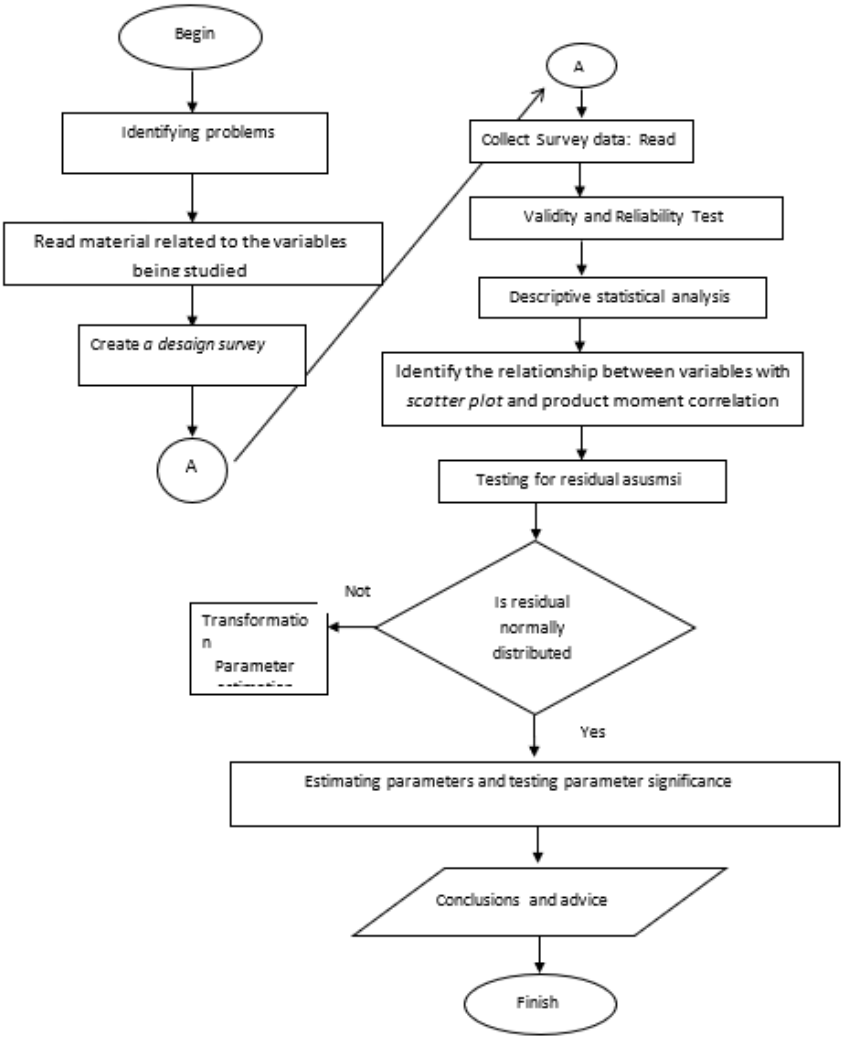
This study aims to analyze the effect of using natural language processing (NLP)-based generative artificial intelligence on 21st-century teaching skills, especially among students of UIN Walisongo Semarang. The research focuses on three NLP platforms, namely Chat GPT, Poe, and Gemini.ai, is relevant as these technologies are increasingly commonly used in the learning process. This study is important because while many studies are exploring AI in education, few have specifically examined how the routine use of NLP platforms can improve teaching skills, such as critical thinking, collaboration, and creativity (Van Laar et.all, 2017). UIN Walisongo, as an Islamic educational institution, faces challenges in integrating technology with pedagogical principles that are in line with Islamic values. Therefore, this study offers a new perspective on understanding how generative AI can play a role in developing 21st-century skills in this unique academic environment (Geisinger, 2016). The findings from this study will not only contribute to the existing literature but also provide practical insights for educators and policymakers in effectively utilizing AI technologies in the Islamic education curriculum in Indonesia

Method

This research is quantitative, using the simple linear regression analysis method. The stages in simple linear regression analysis are: (1) testing the relationship between variables using a scatter plot and Pearson product-moment correlation test, (2) testing the residual assumption of normal distribution, and (3) estimating parameters and parameter significance (James et al., 2023). Before conducting a simple linear regression analysis test, it is necessary to test the validity and reliability first, because the data used in the study uses a Likert scale (Akpos & Jude, 2023). Briefly, the research stages used can be seen in the following flow chart. See Figure 1 to understand the procedure of this research.

The dependent variable (Y1) in this study includes four key 21st-century skills, namely critical thinking (Y1), problem-solving (Y2), collaboration (Y3), and communication (Y4). Critical thinking skills refer to students' ability to analyze, evaluate, and make conclusions based on existing information. Problem-solving measures students' ability to identify problems and find effective solutions. Collaboration focuses on students' ability to work effectively in teams, while communication assesses their ability to convey ideas and information. The independent variable (X) in this study is the use of generative artificial intelligence-based technology supported by natural language processing (NLP). This technology includes three main platforms: GPT Chat, Gemini.ai,

and Poe, which are used by students at the State Islamic University (UIN) Walisongo Semarang. The use of these technologies is expected to influence students' critical thinking, problem-solving, collaboration, and communication skills, as generative NLP technologies can generate relevant content and support the learning process dynamically. This study aims to evaluate the extent to which the use of generative NLP technology can improve these skills in students of UIN Walisongo Semarang.



The data collection technique used in this study was a survey, with procedures carried out systematically. Students were provided with a set of questions designed as a development of indicators of the variables of AI usage and 21st-century skills. These questions were in the form of a Likert scale distributed to students through a Google form, allowing respondents to rate their level of agreement with the given statements (Statistics, 2013). The survey consisted of 84 questions used to identify the extent to

which the use of natural language processing (NLP)-based generative artificial intelligence affects 21st Century skills, such as critical thinking, problem-solving, collaboration, and communication.

Research Respondents

This study involved 301 undergraduate students studying at the Faculty of Education and Teacher Training at UIN Walisongo Semarang. For questionnaire testing, validity and reliability tests were conducted on 140 respondents to ensure that the instruments used were valid and consistent. Meanwhile, data from 301 respondents who filled out the questionnaire, only 270 data could be used because it was considered to meet the requirements. The criteria for respondents who meet the requirements, in this case, are students who use natural language processing (NLP)--based generative artificial intelligence in the form of Chat-GPT, Poe, or gemini.ai platforms for a minimum of 5 hours per week. Respondents were also considered ineligible if they did not complete the Google form. The questionnaires filled out by respondents will be used for simple linear regression analysis to test the relationship between the variables measured. This effort is expected to create reliable data on the influence of AI technology use on 21st-century skills in university students.

Data Analysis

Data analysis in this study used descriptive statistical analysis and inferential statistical analysis. Descriptive statistical analysis is used to describe the data in general. Inferential statistical analysis is used to test the hypothesis (Joshi Kale, Chandel, & Pal, 2015). Hypothesis testing in this study used simple linear regression analysis with a level (α) = 0.050, which was processed with Minitab 16. Before simple linear regression analysis is carried out, the prerequisite test is a normality test using Kolmogorov Smirnov. The criteria used in hypothesis decision-making is H0 rejected when the p-value < α (0.05). On the other hand, H_0 is accepted when the p-value > α (0.05) (Budiyono, 2004).

Validity and Reliability

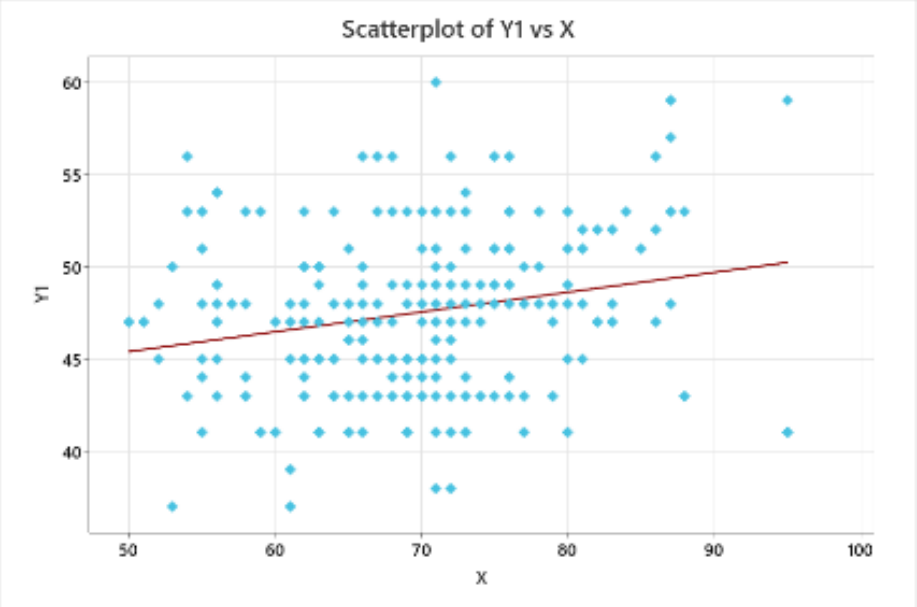
The use of natural language processing (NLP)--based generative artificial intelligence and 21st-century skills of students are measured by survey method with Linkert scale measurement. The instrument that will be used to obtain data must be tested first. The feasibility test of the instrument is carried out in two stages, namely the validity test and the reliability test. This was done to determine the level of quality of the test questions. Validity is an important quality of any test. It is the accuracy and precision of an instrument in carrying out its function (Sugiyono, 2011). Valid means that the instrument can be used to measure. The validity test is to test the instrument whether it is appropriate in identifying the curriculum of the Islamic religious education study program and professional abilities.

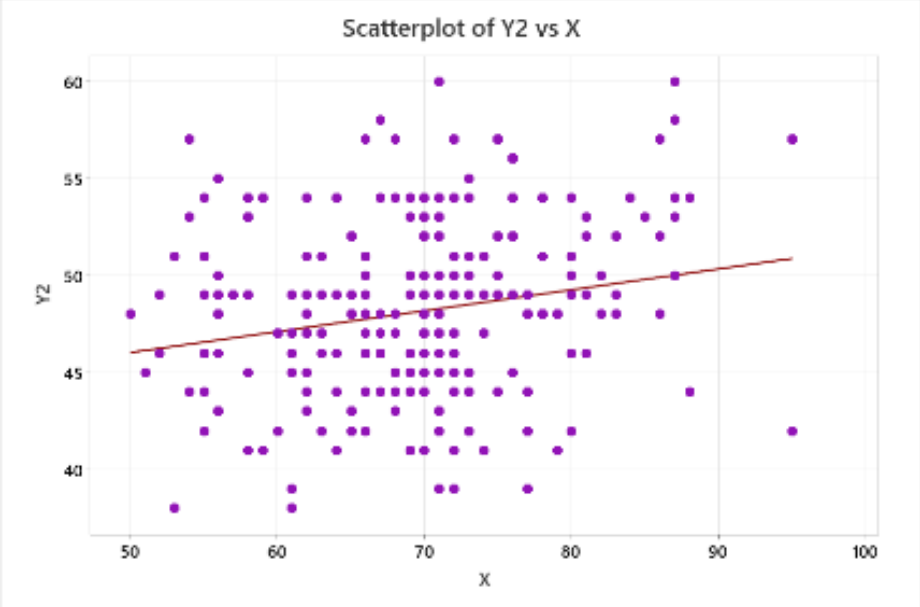
Statement	P-value (X)	P-value (Y1)	P-value (Y2)	P-Value (Y3)	P-Value (Y4)

Statement 1	0,000	0,000	0,000	0,000	0,000
Statement 2	0,000	0,000	0,000	0,000	0,000
Statement 3	0,000	0,000	0,000	0,000	0,000
Statement 4	0,000	0,000	0,000	0,000	0,000
Statement 5	0,000	0,000	0,000	0,000	0,000
Statement 6	0,000	0,000	0,000	0,000	0,000
Statement 7	0,000	0,000	0,000	0,000	0,000
Statement 8	0,000	0,001	0,000	0,000	0,000
Statement 9	0,000	0,000	0,000	0,000	0,000
Statement 10	0,000	0,000	0,000	0,000	0,000
Statement 11	0,000	0,000	0,000	0,000	0,000
Statement 12	0,000	0,000	0,000	0,000	0,000
Statement 13	0,000	0,000	0,000	0,000	0,000
Statement 14	0,000	0,000	0,000	0,000	0,000
Statement 15	0,000	0,000	0,000	0,000	0,000
Statement 16	0,000				
Statement 17	0,000				
Statement 18	0,000				
Statement 19	0,000				
Statement 20	0,000				
Statement 21	0,000				
Statement 22	0,000				
Statement 23	0,000				
Statement 24	0,000				

Results

Based on the figure above, it can be seen that the relationship between the variables of AI use and the critical thinking variable, the variables of AI use and the problem-solving variable, the variables of AI use and the collaboration variable, the variables of AI use and the communication variable, indicates the presence of a linear line. The linear line can be seen from the line that moves from the bottom left to the top right. This indicates a positive correlation or can be said to have a directly proportional relationship. Furthermore, a correlation test can also be carried out to determine the relationship between the bound variable and the independent variable. The following are the results of the correlation test calculations.


Scatterplot of Y1 vs X
Y1
X
60
55
50
45
40
50
60
70
80
90
100


Scatterplot of Y2 vs X
Y2
X
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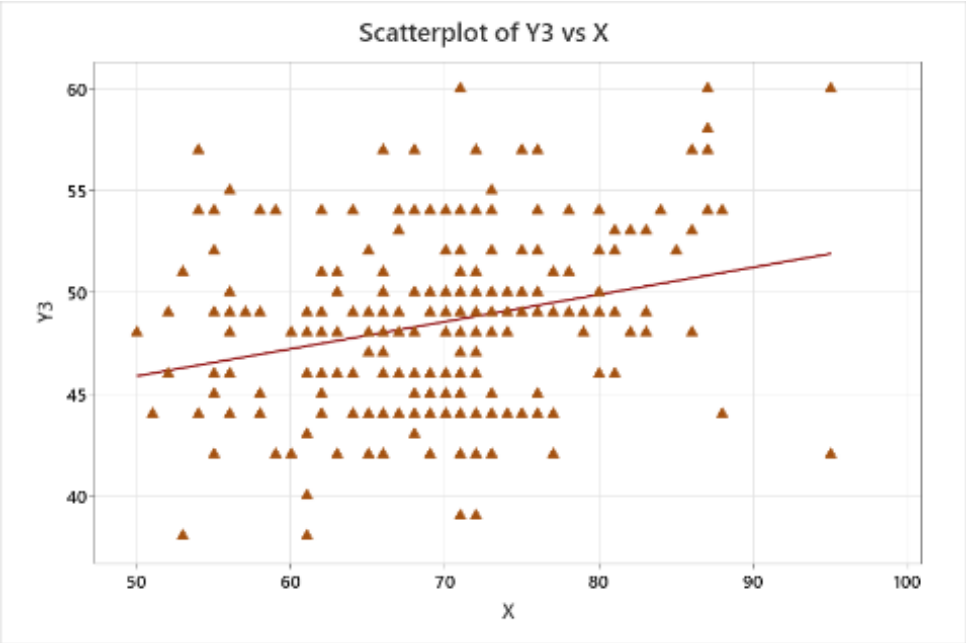


Based on the table above, it can be seen that all *P-values* (0.000) < *alpha* (0.050), so the decision that can be taken is Reject H0, which means that there is a relationship between the variable of AI use and critical thinking, the variable of AI use and the variable of problem-solving, the variable of AI use with the collaboration variable, and the variable of the use of AI with the communication variable, indicating the existence of a linear line.

Variable	X	
	Pearson correlation	***P-value***
Y1	0,207	0,001
Y2	0,204	0,001
Y3	0,257	0,000
Y4	0,170	0,005

1. Simple Linear Regression Analysis of Variable Y_1 with X

The first stage carried out in a simple linear regression analysis is parameter estimation. The following is a simple linear regression model obtained from the results of parameter estimation.

$$\hat{Y}_1 = 40{,}05 + 0{,}1072X$$

The meaning of the simple linear regression model equation above is that if the value of AI users increases by one unit, the critical thinking number increases by 0.1072. The next stage is to conduct a partial test. Here are the results of the partial test analysis.

Table 5. ANOVA

Variable	t	*P-Value*
Y1 VS X	3,47	0,001

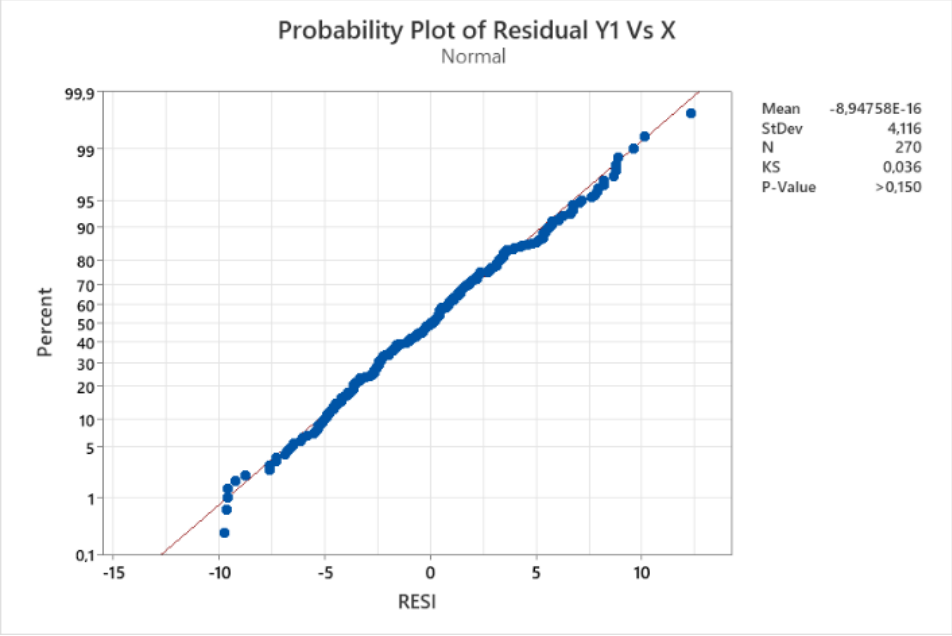
Based on the table above, it can be seen that the value *of P-value* (0.001) < alpha (0.050) and t-count (3.47) > t-table (1.97). This can be taken as a decision, namely rejecting H0. This means that there is a significant influence on AI users on critical thinking. Next, look at the goodness of the model (*R-sq*). Here are the R-sq values obtained.

Table 6. R-sq

No.	R-sq
1.	4,29%

Based on the table above, it can be concluded that the model can explain the diversity of data by 4.29%, while the remaining 95.71% is explained by other variables that are not included in the model. Next, a test of the residual assumption of the Normal distribution was carried out. The following are the results of the analysis of the normal distribution residual assumption test using *the Kolmogorov-Smirnov* method.

Figure 3. Kolmogorov-Smirnov graph between variables Y_1 and X



Based on the figure above, it can be seen that visually the data has been distributed normally because the red plots are located between the linear lines that are formed. When viewed from the results of the normal distribution assumption test using Kolmogorov Smirnov, *the P-value* (>0.150) is greater than *the alpha* (0.05). A decision can be taken, namely failing to reject H_0, meaning that the residual data of AI users on critical thinking has been distributed normally.

1. Simple Linear Regression Analysis of Variable Y_2 with X

The first stage carried out in a simple linear regression analysis is parameter estimation. The following is a simple linear regression model obtained from the results of parameter estimation.

$$\hat{Y}_2 = 40{,}65 + 0{,}1077X$$

The meaning of the simple linear regression model equation above is that if the value of the AI user increases by one unit, the problem-solving figure increases by 0.1077.

The next stage is to conduct a partial test. Here are the results of the partial test analysis.

Table 7. ANOVA

Variable	**T**	***P-Value***
Y2 VS X	3,41	0,001

Based on the table above, it can be seen that the value *of P-value* (0.001) < alpha (0.050) and t-count (3.41) > t-table (1.97). This can be taken a decision, namely rejecting H0. This means that there is a significant influence of AI users on problem-solving.

Next, look at the goodness of the model (*R-sq*). Here are the R-sq values obtained.

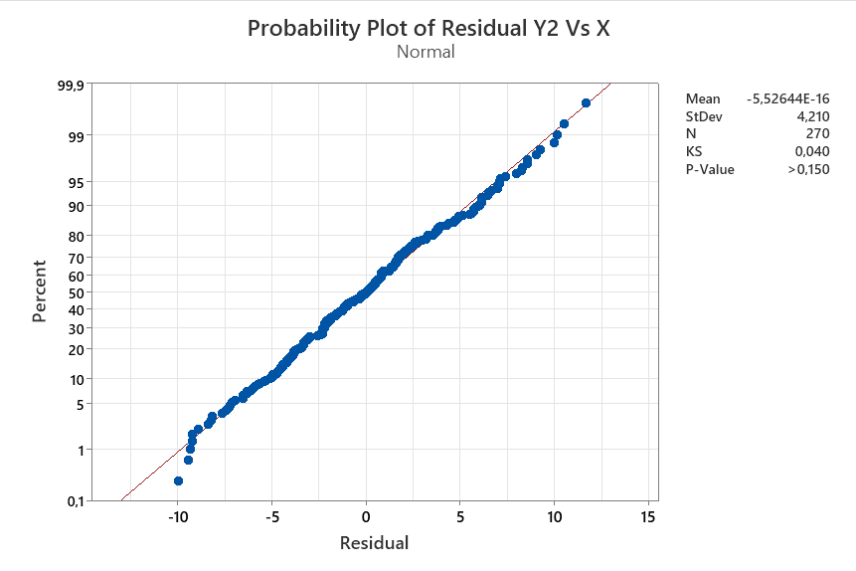
Table 8. R-sq

No.	**R-sq**
1.	4,15 %

Based on the table above, it can be concluded that the model is able to explain the diversity of data by 4.15%, while the remaining 95.71% is explained by other variables that are not included in the model.

Next, a test of the residual assumption of the Normal distribution was carried out. The following are the results of the analysis of the normal distribution residual assumption test using *the Kolmogorov Smirnov* method.

Figure 5. Kolmogorov-Smirnov graph between variables Y_3 and X



Based on the figure above, it can be seen that visually the data has been distributed normally because the red plots are located between the linear lines that are formed. When viewed from the results of the normal distribution assumption test using Kolmogorov-Smirnov, *the P-value* (>0.150) is greater than *the alpha* (0.05). A decision can be taken, namely failing to reject H_0, meaning that the residual data of AI users for collaboration has been distributed normally.

1. Simple Linear Regression Analysis of Variable Y_4 with X

The first stage carried out in a simple linear regression analysis is parameter estimation. The following is a simple linear regression model obtained from the results of parameter estimation.

$$\hat{Y}_4 = 41{,}47 + 0{,}0922X$$

The meaning of the simple linear regression model equation above is that if the value of AI users increases by one unit, the communication number increases by 0.0922.

The next stage is to conduct a partial test. Here are the results of the partial test analysis.

Table 11. ANOVA

Variable	**t**	***P-Value***
Y3 VS X	2,83	0,005

Based on the table above, it can be seen that *the value of P-value* (0.005) < alpha (0.050) and t-count (2.83) > t-table (1.97). This can be taken a decision, namely rejecting

H0. This means that there is a significant influence of AI users on communication. Next look at the goodness of the model (*R-sq*). Here are the R-sq obtained.

Discussions

This study explores the relationship between the use of natural language processing (NLP)-based generative artificial intelligence and 21st-century skills, namely Critical Thinking, Problem-Solving, Collaboration, and Communication. Based on the results of statistical analysis, this study found that the use of natural language processing (NLP)-based generative artificial intelligence has a significant influence on all four skills. Collaboration (Y3) is the skill most affected by AI, with a P-value of 0.000 which is much smaller than alpha 0.050, as well as a t-count of 4.36 which is greater than the t-table of 1.97. This suggests that the use of AI substantially strengthens the collaborative ability of individuals, this is because AI enables more effective coordination and more efficient communication within teams. The second rank was achieved by critical thinking skills (Y1), showing a significant effect with a P-value of 0.001 and a t-count of 3.47, indicating that AI promotes improved analytical and evaluative skills. AI can provide relevant and complex data, thus stimulating individuals to think more deeply and critically in solving problems.

Problem Solving (Y2) was also significantly affected by the use of natural language processing (NLP)-based generative artificial intelligence, with a P-value of 0.001 and a t-count of 3.41. This suggests that AI assists individuals in identifying innovative and effective solutions to complex challenges. AI can provide various alternatives and simulations that facilitate the problem-solving process. Communication (Y4) is the skill least affected by AI compared to the other skills, with a P-value of 0.005 and a t-count of 2.83, although it remains significant. This may be because AI supports but does not replace interpersonal communication skills, but rather strengthens the way of communication by providing tools, such as natural language processing. Overall, this study confirms that AI plays an important role in improving 21st-century skills, especially in the aspect of collaboration, which enables individuals to work more effectively in teams and is followed by improvements in critical thinking, problem-solving, and communication skills.

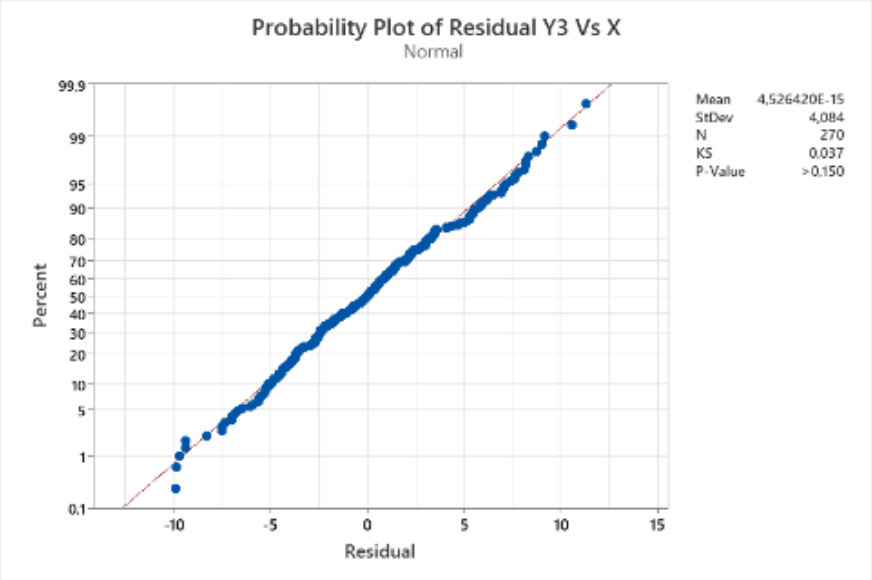
Variable Name	P-Value	Alpha	T-Count	T-Table	Conclusion
Use of AI (X) vs. Collaboration (Y3)	0,000	0,050	4,36	1,97	Significantly, there is a positive relationship

Use of AI (X) vs. Critical Thinking (Y1)	0,001	0,050	3,47	1,97	Significantly, there is a positive relationship
AI Usage (X) vs. Troubleshooting (Y2)	0,001	0,050	3,41	1,97	Significantly, there is a positive relationship
Use of AI (X) vs. Communication (Y4)	0,005	0,050	2,83	1,97	Significantly, there is a positive relationship

In the context of 21st-century skills, the Technology Acceptance Model (TAM) theory provides relevant insights into why natural language processing (NLP)-based generative artificial intelligence has the most influence on collaboration capabilities. TAM, developed by Davis, focuses on two main aspects: perceived usefulness and perceived ease of use (Sánchez-Prieto, 2019). The use of NLP-based generative AI, such as Chat GPT, Poe, and Gemini.ai, can enhance collaboration capabilities as these technologies enable more efficient and productive communication between individuals (Alhashmi & Abdallah, 2019). This is in line with the results of Cruz-Benito et al. (2019) who noted that these NLP-AIs facilitate faster information exchange, support real-time co-creation of content, and provide constructive advice and feedback in the group work process. Chatterjee's (2021) study mentions that, by processing natural language and providing relevant responses, NLP-AI reduces communication barriers and speeds up the process of completing collaborative tasks. In addition, Cruz-Benito's (2019) argument that the ease of access and use of generative AI can allow team members to focus more on achieving a common goal rather than addressing technical or language issues seems relevant to this study. Therefore, in the perspective of TAM theory, the perceived usefulness and ease of use of NLP-based generative AI significantly contribute to the improvement of collaboration ability in the context of 21st-century skills (Na et al., 2019).

Although it seems to support previous research, the findings in this study also contradict previous studies. Muthmainnah, Ibna Seraj, & Oteir, (2022) argued that the use of Gemini.ai was ineffective in improving problem-solving skills as it was considered to be the cause of limitations in interaction and contextual understanding. Grant & Üngör (2024) also argued that ChatGPT sometimes generates irrelevant responses due to a lack of deep understanding of the complex context and subtle nuances in human communication. This is why NLP-AI may reduce students' opportunities to improve their problem-solving skills. This is in line with Ng et al.'s (2023) argument that AI's problem-solving skills are often limited to pre-programmed patterns, making it less able to cope with situations that are unexpected or require creative thinking and innovative solutions. In contrast, the findings in this study suggest that NLP-AI provides opportunities for students to improve their critical thinking skills as it presents diverse perspectives and challenges that encourage students to explore and evaluate solutions

from multiple points of view (Reaves, 2019). AI's ability to provide quick and relevant feedback allows students to engage more frequently in critical thinking processes and strategy adjustments in dealing with complex problems.



In addition, this study also refutes the findings of Mazzucato & Larghi, (2024) who claimed that interaction with AI replaces the social and emotional aspects of human communication, which are crucial in the development of effective communication skills. Despite the relatively small impact on communication skills, the findings in this study still show that natural language processing (NLP)--b generative artificial intelligence affects improving communication skills (Eguchi, 2016). In this context, the findings of this study support Oktradiksa et al.'s (2021) argument that communication skills and creative problem-solving are greatly helped by tools that can respond to student requests with structured language, such as those presented by ChatGPT and Poe. Such interactions with AI allow students to practice and improve their communication skills through structured feedback, although it is still important to consider human interaction as a crucial component in communication development (Hiroyuki, 2021). Thus, while AI may not completely replace the social and emotional aspects of communication, it still makes a positive contribution to improving students' communication and problem-solving skills.

Based on the results of this study, Islamic higher education institutions should take a strategic approach to maximize the benefits of using natural language processing (NLP)--based generative artificial intelligence (AI) while minimizing over-reliance on this technology. First, institutions should integrate in-depth training and education on AI into their curriculum, ensuring that students understand not only how the technology works

but also its limitations (Celik et al., 2022). This includes training on AI ethics, data-driven decision-making, and critical skills for evaluating AI-generated outcomes. Second, institutions should promote the use of AI as a tool, not a substitute, in the teaching-learning process. AI should be used to enhance students' analytical skills and creativity, not to replace critical thinking and independent reasoning (Reed, 2020). In addition, institutions need to set clear guidelines on the limits of AI use in academic tasks to prevent unhealthy dependency. Finally, institutions should encourage collaboration between technology and conventional teaching, ensuring that AI serves as an enriching adjunct to the educational experience and not as the sole source of knowledge (Fadli & Iskarim, 2024). This approach will help to create a balanced and effective educational environment, where AI is optimally utilized without overriding essential human skills

Conclusion

This study confirmed that there is a significant and positive relationship between the use of natural language processing (NLP)--based generative artificial intelligence and the various 21st-century skills studied. The use of AI consistently showed a positive influence on collaboration, critical thinking, problem-solving, and communication skills. Each of these skill variables showed significant results when tested with the use of AI, characterized by test values that were higher than the expected values. This means that the more frequent or intensive the use of AI, the more collaboration, critical thinking, problem-solving, and communication skills improve. Thus, AI serves not only as a technological tool but also as an effective medium to support the development of essential skills in education and employment. The findings reinforce the view that AI can be integrated into learning and training processes to facilitate the development of skills essential for success in the digital age.

Despite successfully showing surprising findings, this study, which was only conducted in one place, namely UIN Walisongo Semarang, has limitations in terms of the generalizability of the findings. The results of this study may not be able to represent a wider population, especially in the context of other universities that have different student characteristics, curricula, and technology use. In addition, the quantitative approach, although providing strong statistical data, does not dig deep into understanding how this technology affects the learning and teaching process from the perspective of students. In the future, researchers should consider expanding the scope of the study to several different locations to increase external validity. A mixed-methods approach can also be used, which combines quantitative data with qualitative interviews or observations, to get a more holistic picture of the impact of the use of NLP-based generative AI. Longitudinal research that tracks changes in student skills over a longer period can also provide more comprehensive insights into the influence of this technology on the development of 21st-century skills, resulting in more reliable and widely applicable findings

This paper has limitations in data sources that only rely on observational research and interviews in remote areas both online and in meetings so it cannot be used as a strong basis for making broad claims about Malay Muslim organizations in Indonesia or throughout Asia. Policy formulation as broad knowledge requires a broad search of the strategies of Malay Muslim organizations in Indonesia. Research on Malay is ongoing and looks at aspects of cultural research that are the values of local wisdom of the Malay community. In future studies, researchers will try to accommodate a broad sample and various sources of information can be knowledge for future writers and researchers.

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