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The Effectiveness of Teams Games Tournament (TGT) Based on Paired Cards on Elementary School Students' Critical Thinking Skills in Fraction Material

Anisa Diah Wardani[1*], Karsono[2], Sandra Bayu Kurniawan[3]
[1,2,3]Universitas Sebelas Maret, Surakarta, Indonesia

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ABSTRACT

This study aims to analyze the effectiveness of the Teams Games Tournament (TGT) learning model based on paired cards on elementary school students' critical thinking skills in fractions. This study used a quantitative approach with a quasi-experimental method and a matching-only pretest-posttest control group design. The sampling technique used was cluster random sampling, with a sample size of 78 students, consisting of 40 students in the experimental group and 38 students in the control group. Data collection was conducted using a critical thinking ability essay test containing indicators for interpretation, analysis, and evaluation. Data analysis was carried out using normality test, homogeneity test, N-gain test, and independent sample t-test assisted by SPSS Statistics 25. The results of the study showed that the paired card-based TGT model had a positive influence on the critical thinking skills of elementary school students with a significance value of 0.001 in the independent sample t-test. The experimental group achieved a higher increase in critical thinking skills (0.7048) compared to the control group (0.6090). Learning activities involving group discussions, educational games, and tournaments can increase student engagement in the mathematics learning process. This research shows that game-based cooperative learning models can be used as an alternative mathematics learning strategy to develop elementary school students' critical thinking skills. Furthermore, the use of matching cards can help create more active, collaborative, and meaningful learning. This study integrates the Teams Games Tournament (TGT) model with paired card media in elementary school mathematics learning to improve students' critical thinking skills on fraction material, which has been limitedly studied in previous studies.

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INTRODUCTION

Critical thinking skills are a key competency for students in the 21st century, particularly in mathematics. These skills are essential for analyzing information, solving problems, making logical decisions, and facing increasingly complex global challenges. However, various international reports, such as the results of the 2022 Programme for International Student Assessment (PISA) conducted by the OECD (Organization for Economic Co-operation and Development), indicate that Indonesian students' critical thinking skills in mathematical literacy are still relatively low and inadequate to face global challenges (Kemendikbudristek, 2023). This condition indicates that students still experience difficulties in understanding concepts, reasoning, and solving contextual mathematical problems that require higher-order thinking skills.

The importance of critical thinking skills in the world of education has also been mandated in various national regulations, such as in Law Number 20 of 2003 concerning the National Education System Article 3 which explains that national education aims to develop the potential of students to become human beings who believe in and fear God Almighty, have noble character, are healthy, knowledgeable, capable, creative, independent, and become democratic and responsible citizens. This explanation shows that the Indonesian education system is not only oriented towards mastering knowledge, but also emphasizes the development of logical, analytical, and critical thinking skills. Likewise, based on Permendikbud Number 22 of 2016 concerning Elementary and Secondary Education Process Standards also

emphasizes that the principle of learning requires teachers to develop learning activities that stimulate high-level thinking skills (HOTS), one of which is through critical thinking skills (Kemendikbud, 2016).

Critical thinking skills are students' skills in reasoning, analytical thinking, and evaluation in facing problems, seeking solutions, and solving problems (Amalia et al., 2021). Mastering critical thinking skills can help students understand problems and find logical solutions, particularly in mathematics. Critical thinking encompasses not only calculation skills but also analytical skills, problem-solving, logic training, and conceptual understanding, equipping students to think logically, systematically, and creatively (Dahlia et al., 2020). In line with this opinion, according to Dewi and Nurhafsah (2020) explains that critical thinking skills also provide important benefits for students, including improving problem-solving skills, fostering a reflective attitude, and encouraging independence in learning. This is in accordance with the context of mathematics learning, which does not only direct students to memorize formulas, but also to understand concepts in depth to form reflective and systematic thought patterns.

However, elementary school teachers in mathematics learning are still very dominant in using lecture methods, and do not involve and pay enough attention to how students respond in learning (Wicaksana et al., 2023). This situation causes students to become more accustomed to passively receiving information rather than analyzing or evaluating the problems presented. However, students with critical thinking skills will respond positively by conducting analysis and evaluation before determining the appropriate and appropriate course of action to resolve the problem (Aini et al., 2022). Critical thinking skills are one of the important demands in the curriculum to be developed, in addition to creative, logical, practical and independent thinking skills (Nadhiroh, S., & Anshori, I., 2023). However, in reality, students' critical thinking skills are still difficult to develop, especially in mathematics. One of the reasons why critical thinking skills are difficult to develop is the lack of attention to factors that can support the development of critical thinking skills, such as students' physical condition, lack of motivation to learn, anxiety levels, and intellectual development (Dores et al., 2020). If these factors are not met, it can result in various weaknesses such as students' low understanding of mathematical concepts and dependence on memorization, making it difficult for students to solve problems logically (Utami, Y, 2025).

Pre-research observations conducted at several elementary schools in Nguter District revealed that the learning process remains conventional and teacher-centered, with a dominant lecture method. During math lessons, teachers deliver the material, provide examples of problems, and ask students to complete exercises in textbooks. Consequently, this learning process appears passive due to the lack of active teacher-student involvement and interaction. However, in the context of mathematics, this approach doesn't provide enough space for students to engage in critical thinking. Furthermore, such learning can diminish student interest and motivation due to the monotony of instruction without the aid of media to help students more easily grasp mathematical concepts. Where this is also reinforced by research Andini, et al (2023) which shows that there are still many students who have difficulty understanding mathematical concepts in real life.

Students' difficulties in understanding mathematics learning materials will certainly have various negative impacts on the students themselves, such as on the grades they will obtain. Based on the results of observations of daily mathematics scores for grade IV Elementary Schools (SD) in Nguter District from four elementary schools, it shows that the achievement of student mathematics scores in the four elementary schools is still relatively low and not optimal. The average score obtained is in the range of 60.70 to 68.33, which indicates that in general, students in these elementary schools have not reached the expected competency standards. The relatively low minimum scores, such as 23 in SD1 and 40 in SD2, further reinforce the idea that some students are experiencing serious difficulties understanding the material. Therefore, learning innovations that create an active, engaging, and meaningful learning environment are needed to improve students' critical thinking skills and mathematics learning outcomes.

Based on the several indications of the problems above, a more participatory, challenging, and exploratory learning model is needed to help improve students' mathematical understanding, such as the Teams Games Tournament (TGT) model. The TGT learning model was chosen because it can create active, collaborative, and enjoyable learning through group competitions, allowing students to discover the concepts they are learning (Rosyada, R. K., & Waluyaningrum, I. H., 2025). In addition, the TGT model prioritizes the concept of playing in achieving learning objectives so that students become more enthusiastic, passionate, and avoid a monotonous classroom atmosphere (Arini & Sukriono, 2024). The TGT model in the learning process also prioritizes tournament-shaped competition which can provide positive encouragement for students to work hard in achieving learning goals, as well as increasing student motivation and participation (Lail et al., 2025). Palupi, I. D. R., & Rahayu, T. S. Research (2021) also proves that the application of the TGT model can significantly increase the percentage of critical thinking skills in mathematics compared to other models.

To increase its effectiveness, the Teams Games Tournament (TGT) model can be combined with the use of relevant learning media (Listiyani, M., & Chamdani, R. H., 2020). One of the learning media that can be used simultaneously with the TGT model is matching cards which involve the activity of actively matching questions and answers (Apriliana, N., & Arini, N. W., 2024). The use of matching cards can increase curiosity, involvement, and interaction between students in learning (Harahap, S. D., & Lestari, A., 2024). In addition, research Liang, S., (2021) it has also been proven that matching cards can have many positive impacts, such as increasing student engagement, stimulating learning interest, enhancing interaction, and encouraging students to make connections between mathematical concepts. Thus, the combination of the Teams Games Tournament (TGT) model and matching cards provides a great opportunity to create more contextual and meaningful mathematics learning. Furthermore, this combination is also in line with the concrete operational development of elementary school students, who learn effectively through social interaction, objects, and games (Wella Hardilia et al., 2023).

Various previous studies have examined the application of the TGT model and paired card media, such as research Ismiyanti and Joharmawan (2023) shows that the application of the TGT model using paired cards can increase students' learning motivation in each cycle, namely cycle 1 and cycle 2 by 24%. Likewise, based on research conducted by Mao et al. (2021) shows that Game-Based Learning (GBL) consistently has many positive impacts on students' critical thinking skills. Based on the results of previous research, most studies still focus on improving learning motivation and learning outcomes in general, while research that specifically examines the effect of the Teams Games Tournament (TGT) model based on paired cards on elementary school students' critical thinking skills in mathematics is still limited. Furthermore, research related to the application of this model in the context of elementary schools in Nguter District has also been limited, even though the mathematics learning process in the region still tends to use a conventional approach that does not encourage students' activities and critical thinking skills.

Based on the description, there is a research gap, namely the lack of research that specifically tests the effectiveness of the Teams Games Tournament (TGT) model based on paired cards on the critical thinking skills of elementary school students in mathematics learning. In fact, the combination of models and media has great potential to create active, enjoyable learning and is able to encourage students to think more critically through discussion activities, games, and problem-solving. Therefore, this study is important to conduct to analyze the effectiveness of the Teams Games Tournament (TGT) model based on paired cards on the critical thinking skills of elementary school students in mathematics learning. This research is expected to provide theoretical contributions in the development of innovative learning models and become an alternative practical solution for elementary school teachers in creating more active, interesting, and meaningful mathematics learning.

METHOD

This research uses quantitative research. The method used in this research is the experimental method. According to Sugiyono (2022) the experimental method is a quantitative research method used to determine the effect of independent variables (treatments) on dependent variables (outcomes) under controlled conditions. This study used a quasi-experimental design with a matching-only pretest-posttest control group design. This design can be seen in the formula below:

Table 1. The Matching Only Pretest-Posttest Control Group Design chart

Experimental Group	M	O	X	O
Control Group	M	O	C	O

(Fraenkel &Wallen, 2011)

So in this study, the experimental group will be given treatment in the form of a TGT model based on paired cards, while the control group will be given treatment in the form of a direct model based on LKPD. However, before being given treatment, each group will be given a pretest to measure the students' initial abilities and a posttest after the treatment to see any changes or effects of the treatment. The pretest and posttest used in this study consist of three essay test questions that contain indicators of critical thinking skills of interpretation, analysis, and evaluation. The outline of the essay test questions for the pretest and posttest is as follows.

Table 1. Pretest Question Grid

Indicator	Sub Indicators	Number
Interpretation	Order the fractions with the numerator one and explain the reasons.	1
Analysis	Analyze equivalent fractions and explain why	2
Evaluation	Evaluate the truth of story problems involving fractions with the same denominator and explain the reasons.	3

Table 2. Posttest Question Grid

Indicator	Sub Indicators	Number
Interpretation	Order fractions with the same denominator and explain why.	1
Analysis	Analyze equivalent fractions and explain why.	2
Evaluation	Evaluate the truth of the fraction story problem with the numerator of one and explain the reasons.	3

Before being used in the study, the test instrument was first tested to determine its suitability. Instrument testing included validity, reliability, difficulty level, and item discrimination. Content validation was conducted by two mathematics education lecturers, two principals, and one teacher. Furthermore, the sampling technique used in this study was cluster random sampling. Therefore, the population of this study was all elementary school clusters in Nguter District, while the sample in this study consisted of six elementary schools divided into two groups as follows.

Table 3. Research Sample

Nu.	Experimental Group		Control Group	
1	SD1	13	SD2	18
2	SD3	14	SD4	10
3	SD6	13	SD5	10
Total	**40**		**38**	

After the pretest and posttest data were obtained, data analysis was conducted using SPSS Statistics 25. The analysis used consisted of descriptive and inferential statistics. Prerequisite tests included normality and homogeneity tests. Furthermore, the N-gain test was used to determine the increase in students' critical thinking skills, while hypothesis testing was conducted using an independent sample t-test to determine the difference in critical thinking skills between the experimental and control groups.

RESULTS

This study aims to reveal the effectiveness of the paired cards-based TGT model on the critical thinking skills of fourth-grade students in fractions in elementary schools in Nguter District. The following are some of the statistical tests conducted.

1. Descriptive Statistical Analysis

Table 4. Results of Descriptive Statistical Analysis of the Pretest of the Experimental Group and the Control Group

Description	Pretest		Posttest	
	Experimental Group	Control Group	Experimental Group	Control Group
Minimium	6,7	6,0	58,3	40,0
Maximum	63,3	67,0	100,0	100,0
Mean	40,753	28,045	83,238	73,071
Standard Deviation	14,2137	15,6895	10,3244	14,5972
Variance	202,030	246,160	106,594	213,077
N	40	38	40	38

Based on Table 4, at the pretest stage, the average score for the experimental group was 40.753. Meanwhile, the control group obtained an average of 28.045. These data indicate that the initial abilities of students in the experimental group were higher than those of the control group. Furthermore, the standard deviation for the experimental group was 14.2137 and for the control group was 15.6895, indicating that the distribution of data in the control group was more varied than that of the experimental group.

In the posttest, both groups experienced an increase in their average scores. The experimental group obtained an average of 83.238. Meanwhile, the control group obtained an average of 73.071. These results indicate that the increase in learning outcomes in the experimental group was higher than the control group. Furthermore, the standard deviation of the experimental group in the posttest was 10.3244, while the control group's was 14.5972. This indicates that the learning outcomes in the experimental group were more homogeneous than those in the control group. Furthermore, the larger variance of the control group compared to the experimental group also indicates that the distribution of scores in the control group was more diverse.

2. Normality Test

Table 5. Normality Test Results

	Class	Shapiro-Wilk		
		Statistic	**df**	**Sig.**
Results	Pretest Control	.946	38	.064
	Posttest Control	.978	38	.652
	Experiment Pretest	.956	40	.126
	Experiment Posttest	.962	40	.190
*. This is a lower bound of the true significance.				
a. Lilliefors Significance Correction				

Based on Table 5. the results of the normality test using Shapiro-Wilk, it is known that the significance value (Sig.) in the control class pretest data is 0.064, the control class posttest is 0.652, the experimental class pretest is 0.126, and the experimental class posttest is 0.190. Since all significance values are > 0.05, it can be concluded that the data in each group is normally distributed. Thus, the research data meets the assumption of normality so that it can be continued with parametric statistical testing.

3. Homogeneity Test

Table 6. Results of the Pretest Homogeneity Test

		Levene Statistic	**df1**	**df2**	**Sig.**
Pretest Results	Based on Mean	1.102	1	76	.297
	Based on Median	.831	1	76	.365
	Based on Median and with adjusted df	.831	1	75.998	.365
	Based on trimmed mean	1.042	1	76	.310

Based on Table 6, the results of the pretest homogeneity test using Levene's Statistic, obtained a significance value of 0.297 based on the mean. Since the Sig. value is > 0.05, it can be concluded that the pretest data variance between the control group and the experimental group is homogeneous, meaning that both groups have the same variance, thus fulfilling the requirements for further statistical analysis.

Table 7. Results of the Posttest Homogeneity Test

		Levene Statistic	**df1**	**df2**	**Sig.**
Posttest Results	Based on Mean	3.319	1	76	.072
	Based on Median	3.225	1	76	.077
	Based on Median and with adjusted df	3.225	1	66.881	.077
	Based on trimmed mean	3.244	1	76	.076

Based on Table 7, the results of the posttest homogeneity test using the Levene test obtained a significance value (Sig.) of 0.072, which means the significance value is greater than 0.05 (0.072 > 0.05), so the posttest data in the experimental group and the control group are declared homogeneous or have the same variance. Thus, the requirements for continuing the analysis using the Independent Sample t-test have been met.

4. N-gain test

In this study, an N-gain (Normalized Gain) test will be conducted to measure improvements in student learning outcomes after instruction. The requirements for this N-gain test are as follows.

Table 8. Provisions for N-gain Score Distribution Categories

Nilai N-gain	Categories
g > 0,7	High
0,3 ≤ g ≤ 0,7	Currently
g < 0,3	Low

Table 9. Interpretation Categories of N-gain Score Effectiveness

Percentage	Interpretation
< 40	Ineffective
40 – 55	Less Effective
56 – 75	Quite Effective
>76	Effective

The following are the results of the N-gain test of the pretest and posttest data for the control group and the experimental group as follows.

Table 10. Results of the N-gain Test for the Control Group

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain_Score	38	-.09	1.00	.6090	.23269
Ngain_Persen	38	-9.09	100.00	60.9010	23.26896
Valid N (listwise)	38				

Based on Table 10, the N-gain score test results in the control group obtained an average of 0.6090, which means it is included in the moderate category. Furthermore, the average N-gain percentage of the control group was 60.9010%, which means it is interpreted as being in the fairly effective category. These findings indicate that learning in the control group using the direct model assisted by LKPD was able to improve student learning outcomes, but the increase that occurred was still at a moderate level and its effectiveness was relatively limited.

Tabel 11. Hasil Uji N-gain Kelompok Eksperimen

	N	Minimum	Maximum	Mean	Std. Deviation
Ngain_Score	40	.29	1.00	.7048	.18517
Ngain_Persen	40	28.69	100.00	70.4801	18.51721
Valid N (listwise)	40				

Based on Table 11, the N-gain score test results in the experimental group were 0.7048, which means they are in the high category. In addition, the average N-gain percentage in the experimental group was 70.4801%, which is included in the fairly effective category. These results indicate that learning using the TGT model assisted by paired cards applied to the experimental group was able to provide better learning outcomes compared to the control group. The higher average N-gain value and smaller standard deviation also indicate that the improvement in learning outcomes in the experimental group tended to be more optimal and more evenly distributed among students.

5. Independent Sample t-Test

Next, to compare the averages of two independent (unpaired) groups to determine whether the difference in the averages is statistically significant or just happens by chance, an independent sample t-test is carried out with the following provisions.

a) If Sig. < 0.05, then there is a significant difference between the two groups;
b) If Sig. > 0.05, then there is no significant difference.

The following are the results of the independent sample t-test for the control group and the experimental group.

Table 12. Results of the Independent Sample t Test on Posttest Data Results

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	T	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Posttest	Equal variances assumed	3.319	.072	-3.565	76	.001	-10.1664	2.8514	-15.8454	-4.4875
	Equal variances not assumed			-3.535	66.315	.001	-10.1664	2.8761	-15.9083	-4.4246

Based on the results of the independent sample t-test in Table 12, the significance value obtained in the Levene's Test was 0.072, which means the significance value is greater than 0.05. Thus, the data from both groups are declared homogeneous or have the same variance. Then, the t-test analysis using the Equal Variances Assumed row shows that the 2-tailed sig. value is 0.001, which means the significance value is less than 0.05, so there is a significant difference between the critical thinking abilities of students in the experimental group and the control group. Thus, the null hypothesis (H0) is rejected, and the alternative hypothesis (Ha) is accepted.

DISCUSSION

The results of the study indicate that the implementation of the Teams Games Tournament (TGT) model based on paired cards has a significant influence on the critical thinking skills of elementary school students. This is evident from the results of the independent sample t-test which shows a significance value < 0.05 and the average N-gain of the experimental group is 0.7048 with a high category, while the control group obtained an average N-gain of 0.6090 with a medium category. This finding answers the formulation of the research problem that the use of the TGT model based on paired cards is able to improve students' critical thinking skills more optimally than direct learning based on LKPD. The difference in improvement shows that learning activities involving games, group discussions, and academic competitions are able to create more active and meaningful learning for elementary school students.

Empirically, the results of this study are in line with previous research which shows that the TGT type cooperative learning model is effective in improving students' critical thinking skills. Research conducted by Nisa, Z. L., et al. (2024) stated that TGT is able to increase learning participation, social interaction, and active involvement of students in the learning process. In addition, research Eliani, N., dan Apriza, B. (2025) also shows that the use of game media in mathematics learning can help students understand concepts in a more concrete and enjoyable way. In the context of this research, paired cards not only function as a game medium, but also as a means to train students' interpretation, analysis, and evaluation skills in solving fraction problems.

From a theoretical perspective, this finding is in line with Vygotsky's social constructivism theory which emphasizes that knowledge is constructed through social interactions and collaborative activities (Aprianti et al., 2025). The TGT model, based on paired cards, provides students with opportunities to discuss, exchange ideas, and solve problems together in heterogeneous groups. This allows students to build conceptual understanding through scaffolding and peer interactionIn addition, the use of game and tournament elements in TGT also supports Jerome Bruner's learning theory which emphasizes the importance of direct activities and experiences in the learning process (Nitbani, 2020).

The high N-gain value in the experimental group shows that educational game-based learning can increase students' cognitive engagement more deeply than conventional learning (Wulansari, A. 2025). The activity of matching question and answer cards requires students to think actively, analyze relationships between fractions, and evaluate the accuracy of their answers. This allows students to engage in independent and collaborative concept discovery, not just passively receiving information. In contrast, in the control group, direct instruction based on student worksheets (LKPD) tended to be more teacher-centered, thus limiting student interaction and exploration of ideas.

However, this study has several limitations. Sugiyono (2022) stated that the limitations of the sample and scope of the study may affect the level of generalizability of the results. First, the research subjects came from only a few elementary schools in Nguter District and were limited to fraction material, so the results do not fully represent the conditions of elementary schools in general. Second, the indicators of critical thinking skills used in this study only cover interpretation, analysis, and evaluation, so they do not describe all aspects of critical thinking skills. Third, this study did not examine other factors that may influence students' critical thinking skills, such as learning motivation, learning styles, or communication skills during the learning process.

The practical implications of this study indicate that the TGT model based on paired cards can be used as an innovative learning alternative to improve elementary school students' critical thinking skills, particularly in mathematics learning about fractions. Teachers can utilize educational games as a strategy to create a more interactive, collaborative, and enjoyable learning environment. Furthermore, the results of this study also demonstrate the importance of integrating cooperative activities and concrete media in 21st-century learning to train students' higher-order thinking skills from elementary school on (Realitawati, R., et al. 2024).

In terms of theoretical implications, this study strengthens the view that game-based cooperative learning has a positive contribution to the development of students' critical thinking skills (Fatmawati, R., & Siregar, T. J. 2026). The paired-card TGT model not only impacts cognitive learning outcomes but also fosters social skills, communication, and cooperation among students. Therefore, further research is recommended to expand the application of the TGT

model to other mathematics materials or combine it with other learning approaches to gain a more comprehensive understanding of the learning model's effectiveness on elementary school students' critical thinking skills.

Overall, the research results indicate that the paired-card TGT model has a positive and significant impact on elementary school students' critical thinking skills. These findings emphasize that learning involving collaborative activities, educational games, and active student participation can create a more meaningful learning process than conventional learning. Therefore, the use of innovative game-based learning models needs to be continuously developed to improve the quality of mathematics learning in elementary schools.

CONCLUSION

Based on the research results, the Teams Games Tournament (TGT) model based on paired cards has a positive influence on the critical thinking skills of elementary school students in fractions. This is indicated by the results of the posttest, independent sample t-test, and the higher N-gain of the experimental group compared to the control group. However, the results of this study need to be understood according to the context of the research implementation and the characteristics of the subjects involved. This study contributes to the development of elementary school mathematics learning through the application of a game-based cooperative learning model that is able to create more active, collaborative, and meaningful learning. Therefore, the TGT model based on paired cards can be used as an alternative learning strategy to train students' critical thinking skills. However, further research with a wider sample, more balanced group conditions, and more diverse material coverage is still needed so that the research results can be generalized more comprehensively.

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***Anisa Diah Wardani (Corresponding Author)**
Faculty of Teacher Training and Education,
Universitas Sebelas Maret
Jalan Ir. Sutami No. 36A, Kentingan, Jebres District, Surakarta City, Central Java 57126, Indonesia.
Email: anisadiahwardani@student.uns.ac.id

Karsono
Faculty of Teacher Training and Education,
Universitas Sebelas Maret
Jalan Ir. Sutami No. 36A, Kentingan, Jebres District, Surakarta City, Central Java 57126, Indonesia.
Email: karsono@uns.ac.id

Sandra Bayu Kurniawan
Faculty of Teacher Training and Education,
Universitas Sebelas Maret
Jalan Ir. Sutami No. 36A, Kentingan, Jebres District, Surakarta City, Central Java 57126, Indonesia.
Email: sandra.bayu.kurniawan@unm.ac.id