



Does E-Worksheet Based on Tri-N Principles Give Support to Improve Students' Ability to Think Critically and Creatively?

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Abstract

The rationale of this study was students' critical and creative thinking skills in learning mathematics are still low. Many strategies to improve those abilities, one of the strategies is using e-worksheets. This research aims to explore the effect of e-worksheets based on Tri-N Principles give support to improve the creative and critical thinking ability of students in learning mathematics. Tri-N was chosen since one of Ki Hajar Dewantara's principles, including *Niteni*, *Nirokke*, and *Nambahi*. These principles have provided support to improve the creative and critical thinking ability of students in learning. An experimental method with a posttest-only design type was used in this research. The random cluster was used to take a research sample of 52 students from the Junior High School of Pembangunan Piyungan in two classes. The instrument used is a mathematical test in the form of a description which aims to measure students' mathematical critical and creative thinking abilities. The hypothesis test uses multivariate analysis because this study has two dependent variables. The results revealed that the calculated F is 21.612 with a significance coefficient of .000. For this reason, it can be concluded that e-worksheets based on Tri-N principles improve critical and creative thinking skills. So, e-worksheets based on Tri-N principles can be used as an alternative to improve the creative and critical thinking ability of students in learning mathematics.

Keywords: Critical Thinking Skills; Creative Thinking Skills; E-Worksheet; Tri-N

Abstrak

Penelitian ini dilatarbelakangi oleh kemampuan berpikir kritis dan kreatif matematis siswa masih belum optimal. Banyak cara yang dapat dilakukan untuk meningkatkan dua kemampuan tersebut, diantaranya menggunakan *e-worksheet* pada pembelajaran matematika. Tujuan dari penelitian ini untuk mengetahui pengaruh *e-worksheet* berbasis Tri N terhadap kemampuan berpikir kritis dan

kreatif siswa pada pembelajaran matematika. Dipilihnya Tri-N karena salah satu ajaran Ki Hajar Dewantara ini yang dapat menuntun siswa untuk memiliki kemampuan berpikir kritis, kreatif, inovatif dan pemahaman konsep melalui kegiatan Niteni, Nirokke, Nambahi. Metode eksperimen dengan tipe *posttest only design* digunakan pada penelitian ini. *Random cluster* digunakan untuk mengambil sampel penelitian dengan ukuran 52 siswa SMP Pembangunan Piyungan yang tergabung dalam dua kelas. Instrumen yang digunakan adalah tes matematika berbentuk uraian yang bertujuan untuk mengukur kemampuan berpikir kritis dan kreatif matematis siswa. Uji hipotesis menggunakan analisis multivariat karena penelitian ini memiliki dua variabel terikat. Hasil penelitian menunjukkan bahwa F hitung sebesar 21.612 dengan koefisien signifikansi sebesar 0.000. Untuk itu dapat disimpulkan bahwa *e-worksheet* berbasis Tri-N meningkatkan kemampuan berpikir kritis dan berpikir kreatif daripada bahan ajar *e-worksheet* biasa. Berkaitan dengan ini bahan ajar *e-worksheet* berbasis Tri-N dapat digunakan sebagai alternatif dalam pembelajaran matematika untuk meningkatkan kemampuan berpikir kritis dan kreatif matematis siswa SMP.

Kata Kunci: *E-Worksheet*; Kemampuan Berpikir Kritis; Kemampuan Berpikir Kreatif; Tri-N

Introduction

Several factors, such as teachers, students, approaches, and learning models, have influence the quality of education. Teachers are getting the main role in teaching and learning (Yestiani & Zahwa, 2020). Teachers must be creative in providing learning materials so students getting interested and involved. Teaching materials is one of the appropriate methods teachers can use in teaching materials (Husada et al., 2020). Teaching materials make it easier for teachers to convey information so that students easily understand what is being expressed (Ulva & Fitri, 2022). Using suitable teaching materials can increase Critical thinking and creative thinking skills.

Critical thinking skills are thinking skills that involve cognitive processes and encourage students to think about problems in a more reasonable way (Saputra, 2020). Critical thinking is the skill to think logically and systematically when deciding or solving specific problems. The results of previous studies show that this ability is still not satisfactory (Agnafia, 2019; Nuryanti et al., 2018; Priyadi et al., 2018). A survey of 29 students in class VIII A of Junior High School 1 in Delanggu, Klaten, showed that critical thinking skills are still relatively low. Hence, they need further training to improve (Nuryanti et al., 2018). The same results were also reported for students in Vocational High School Bakti Indonesia Media (BIM) Ngawi, indicating that the critical thinking skills in this school were 72%, interpretation of 63%, analysis of 31%, self-regulation of 51%, evaluation of 46%, and inference of 62%, these results indicate that the students only have relatively better explanation abilities compared to other skills (Agnafia, 2019).

There has been a lot of research that focuses on improving critical thinking skills. Such as research that applies guided inquiry learning, discovery learning, flipped classroom, problem-based learning, and project-based learning to enhance critical thinking skills (Amijaya et al., 2018; Insyasiska et al., 2017; Maolidah et al., 2017; Nurrohmi et al., 2017; Satwika et al., 2018). Likewise, several studies have found that worksheets can improve critical thinking skills. Such as using STEM-based worksheets (Novitasari et al., 2022), Ethnoscience e-worksheet on problem-based learning (Wahyuningtyas et al., 2023), worksheets based on comics (Purnama & Suparman, 2020), and worksheets in Team Accelerated Instruction (Rahmadansah et al., 2022).

The ability to think creatively is the ability to create something new, solve problems and find solutions to problems, make innovative plans, consider issues that may arise and overcome them; we know how to do it, and the results we get from careful implementation (Ulandari et al., 2019). Creative thinking is thinking that tries to create new ideas. Creative thinking is a series of processes, including understanding the problem, making guesses and hypotheses about the problem, searching for answers, proposing evidence, and reporting the results. Problems with learning so far include students' weakness in aspects of creative thinking skills needed to solve mathematical problems, so they cannot solve mathematical problems in the form of non-routine questions (Siswono, 2005, 2011, 2016b).

On the other side, the results of preliminary studies conducted by other researchers also show the same thing, it shown that the ability to think creatively in the unsatisfactory category (Almuharomah et al., 2019; Rahayu et al., 2019; Sariningsih & Kadarisma, 2016; Setianingsih & Purwoko, 2019). The results of a preliminary study conducted on students at State Junior High School 2 Balong District showed that the creative thinking ability profile of 55.38% was included in the sufficient category, so this achievement still needs to be improved through diverse learning (Almuharomah et al., 2019). Likewise, from the preliminary study, it was found that students' creative thinking abilities were still in the low category because they made many mistakes in the process of solving mathematical problems (Rahayu et al., 2019; Sariningsih & Kadarisma, 2016; Setianingsih & Purwoko, 2019). This can be caused by teachers not trying to explore students' knowledge and understanding of creative thinking (Rahayu et al., 2019).

There has been a lot of research that focuses on improving creative thinking abilities. Such as research that applies problem-posing learning, problem-solving contextual learning, and scientific learning with an ethnomathematics approach (I. N. Dewi et al., 2019; Rahayu et al., 2019; Sariningsih & Kadarisma, 2016; Siswono, 2004, 2005). Likewise, the use of worksheets, such as the use of worksheet in

Means-Ends Analysis learning (Lestari et al., 2014), worksheets based on problem-solving learning (Firanti & Paidi, 2016; Fitriani et al., 2022), worksheets based on Problem-based learning (Mahendrawan et al., 2022; Tinedi et al., 2015), worksheets based on multiple representations (N. B. Mutia & Prasetyo, 2018), and scientific creativity and critical worksheets (Wulansari et al., 2019).

Critical thinking and creative thinking skills are interrelated because when students think creatively, especially when writing or communicating their ideas, they become the basis for thinking logically and finding the correct answers to the problems they want to solve (Wati & Sari, 2023). This is in line with the results of previous research conducted on students at Senior High School 1 Parungpanjang which showed that the close relationship between students' critical thinking abilities and creative thinking abilities was 52.42% (Mayarni & Yulianti, 2020). Students are said to think critically if they can feel and argue with the right reasons, while students are said to think creatively if they can convey different ideas and strategies, even though they are not the same as usual (Samura, 2019; Siswono, 2016a). Besides that the skill to think critically and creatively can train students to reason logically through arguments, interpretation, evaluation, and being able to conclude so that students are motivated to put forward new, unique ideas in solving a problem. E-worksheets can be teaching material that can improve critical and creative thinking skills (Julian & Suparman, 2020; Subakti et al., 2021).

Many researchers have conducted research related to student e-worksheets and student abilities. These research, including: (1) the influence of e-worksheets on problem-solving skills (Ichsan et al., 2023; Widodo et al., 2023), (2) The effect of e-worksheets on creative thinking abilities (Aripin & Purwasih, 2017; Islamiyati et al., 2023; Purwaningsih et al., 2021), (3) the influence of e-worksheets on mathematical communication skills (Ismail et al., 2020; Riyati & Suparman, 2019), and (4) the impact of worksheets on critical thinking skills (Fernando et al., 2021; Hayati & Setiawan, 2022; Ningrum et al., 2022). The results of these research indicate that worksheets have the potential to improve the creative and critical thinking ability of students in learning. However, learning results show that students' soft and hard skills are still not optimal.

Other research shows that the learning process using e-worksheets get the positive results. It was found that e-worksheets based on a mathematical investigation approach affected critical thinking skills (Puspita & Dewi, 2021). This research was carried out on 68 students of State Elementary School 10 Sungai Sapih, Padang. It was found that in the experimental class, the average was 70.37, with a standard deviation of 9.36, while in the control class, the average was 20.1, with a

standard deviation of 8.94; the t-test calculation obtained 41.12 with a significance coefficient of less than .05.

Other research also states that students' mathematical literacy skills can be improved by using e-worksheets in problem-based learning (Mulyasari, 2023; Munika et al., 2021; Purnama & Suparman, 2020). Based on several studies show that e-worksheets can be used as teaching material for teachers and students, especially in mathematics learning for one-variable linear inequalities. The problems that students often encounter in the material on linear inequalities with one variable are questions in the form of stories, which causes students to experience difficulty in solving problems (Jumiati, 2020; Permaganti & Zanthly, 2023).

Based on these rationales above, it is necessary to develop the study about students' e-worksheets to help the students to learning mathematics. There are at least two things that differentiate this study from previous research that has been carried out. First, this research is a follow-up research conducted by Wijayanti et al. (2021) regarding developing an e-worksheet based on Tri-N products. Second, the effect of e-worksheets seen in this research is the aspect of critical and creative thinking skills because these two abilities are rarely used as the research focus by researchers.

The observations of students' critical and creative thinking skills at the Junior High School of Pembangunan Piyungan in Grade VII revealed still low. Based on the interviews with the teacher, it found that students experienced the difficulties to internalize the mathematical concept. One of the things that can cause these problems is the learning resources teachers use. Teachers do not use various learning resources and only use textbooks from the government as the only source of student learning. On the other side, the teachers just used traditional method in learning mathematics, so the students felt bored. As a result, students' critical and creative thinking skills are not trained.

The problems elaborated above showed the low level of learning outcomes, particularly in students' critical and creative thinking abilities. Tri-N principles can lead students to have critical and creative thinking skills in solving problems (Sutanto et al., 2023). Tri-N is one of the principles of Ki Hadjar Dewantara. Tri-N is a learning model that can be used to foster students' creativity so they can create new things in the world of science from an early age. This needs to be developed to pursue knowledge so that you don't just imitate in the sense of plagiarizing or copying, but it is necessary to develop the knowledge that has been obtained.

The Tri-N principles consists of three part, including *Niteni*, *Nirokke*, and *Nambahi* (Damayanti & Rochmiyati, 2019; A. F. Nisa et al., 2019; Rochmiyati & Putro, 2020; Sibyan et al., 2019; Sunarsih et al., 2023). *Niteni* is a process carried out by students to mark by observing using all the five senses they have, digging for information, and being able to reason by connecting the knowledge they already have from the excavation results. *Nirokke* is a process by which students imitate what teachers or learning resources teach by involving thoughts, sensations, feelings, and spirituality integrally and harmoniously. *Nambahi* is a process by which students add to what they have learned in developing their creativity and ideas through designing, creating, and improvising activities to give a new colour to the model they are imitating.

The preliminary study results showed that using e-worksheets based on tri-n principles give support to improve creative and critical thinking ability of students in learning mathematics (Wijayanti et al., 2021). This preliminary study used RnD method involving 10 people as validators to assessed the e-worksheets on linear equations and single variable inequalities. The another results showed, students experience the process and discover mathematical concepts so that critical thinking abilities or other mathematical abilities can improve (Wijayanto, 2019). On the ather side, previous research related to Tri-N showed the improvement of creative and critical thinking ability in science topics at elementary school level (A. F. Nisa et al., 2019).

Meaningful learning can foster the students more easier to understand new knowledge. This learning can be created if students are actively in the teaching and learning. The teacher's role is as a facilitator in learning mathematics. The alteration of paradigm in the teaching and learning process, from students who sit calmly and silently receiving the material to becoming active students by providing critical arguments, solving problems with the knowledge they have obtained, sharing information they receive outside school, and apply the material they learn in class to real life (Agustina et al., 2024; Marwany et al., 2023). This is in line with the Tri-N Principles, where students mark by paying close attention, digging for information, reasoning, and connecting knowledge using all the five senses they have (*niteni*), then imitating what is taught by the teacher or learning resources by involving the mind, sensing, and feeling (*nirokke*), until in the end they add to what they have learned in developing their creativity and ideas (*nambahi*). Therefore, this study focus on examining the effect of e-worksheet based on Tri-N principles to improve creative and critical thinking ability of students in learning mathematics.

Method

The research method used in this research is quasi-experimental. In the method, subjects are not randomly assigned to experimental or control groups (Creswell, 2012). The design used by the researcher is a posttest-only design type. In this model, the researcher choose two classes randomly. The first class is treated and the other class is not treated. The class treated is called the experimental group and the class that is not treated is called the control group. In this study, the two groups received the same learning method and material about linear inequalities in one variable. Only the experimental class used an e-worksheet based on Tri-N, while the control group used a ordinary e-worksheet.

This research involved the entire class VII population: VII-A, VII-B, and VII-C. The sampling technique uses cluster random sampling. This sampling technique is a random sampling method using selected groups from the population (Lidia et al., 2018). The sample in this study consisted of two classes, namely VII-A and VII-B. Class VII-A was an experimental group with 28 students of 16 males and 12 females. Class VII-B was a control group with 24 students consisting of 12 males and 12 females.

The instruments given in this research are critical thinking and creative thinking test questions. The test used in this research is linear inequality questions on one variable in the form of an essay, totalling 5 questions. This instrument is given at the end of learning (post-test). This test kit was given to the experimental and control classes, each receiving the same test type. This test instrument measures students' critical and creative thinking skills after using e-worksheets based on Tri-N. Indicators of critical thinking skills in this study adapted indicators (1) focus or essential clarification, (2) reason or build reasons related to facts, (3) inference or conclusion, (4) situation or collect relevant information, (5) clarity or further clarification, and (6) overview or Double check the criteria (Aini et al., 2023). Indicators of creative thinking include fluency, flexibility, originality, and elaboration (Dalilan & Sofyan, 2022).

Critical and creative thinking test scoring refers to indicators of critical and creative thinking. To obtain data on students' critical thinking skills, scoring was carried out on student answers for each question item. Critical thinking scoring criteria are presented in Table 1 (Milati et al., 2019).

Table 1. Scoring Guidelines Critical Thinking Skills

Indicators	Student responses to questions	Score
Focus (ability to identify problems)	Not writing what is known and what is asked	0
	Write only what is known and what is asked, but the writing is not precise	1
	Write down what is known and ask the question correctly	2
	Write down what is known and asked from the question accurately and incompletely	3
	Write down what is known of the problem and do the calculations correctly	4
Reason (ability to give reasons)	Not writing what is known and what is asked	0
	Writing answers without giving proper reasons	1
	Just write the answer or give the exact reason	2
	Write answers by giving precise and incomplete reasons	3
	Write answers by giving complete and precise reasons	4
Inference (ability to make conclusions)	Not writing answers and conclusions	0
	Write answers without providing conclusions	1
	Just write the answer or provide an appropriate conclusion	2
	Write answers by providing appropriate and incomplete conclusions	3
	Write answers by providing precise and complete conclusions	4
Situation (ability to answer questions according to context)	Not writing answers	0
	Answers, but it's not quite right	1
	Writing down answers does not include a counting process	2
	Writing down the answer is accompanied by a counting process, but the final answer is not quite right	3
	Write down the answer along with the counting process and include the correct final answer	4
Clarity (the ability to provide further clarity)	Not writing answers	0
	Writing answers without linking concepts	1
	Just write the answer or provide a concept connection	2
	Writing answers with inaccurate concept connections	3
	Write answers with the correct concept connections	4
Overview (check the truth of a statement)	Not writing statements and explanations	0
	Write a true statement without giving a proper explanation	1
	Write only factual statements or provide accurate explanations	2
	Write correct statements by providing precise and incomplete explanations	3

Indicators	Student responses to questions	Score
	Write correct statements by providing precise and complete explanations	4

For each question, creative thinking ability is scored by comparing students' answers with predetermined indicators: fluency, flexibility, originality, and elaboration (Dalilan & Sofyan, 2022). The creative thinking scoring guidelines are presented in Table 2 (Sitorus & Nazaruddin, 2021).

Table 2. Guidelines for Scoring Creative Thinking Skills

Aspect	Indicators	score
Fluency	The answer is incomplete, or the method used did not work	1
	At least one correct answer is given, and one method is used to solve the problem	2
	At least two correct answers are given, and two methods are used	3
	All answers are correct, and several methods are used	4
Flexibilities	Didn't answer the question	0
	Answering questions incorrectly and without variety	1
	Provide answers to questions that are not varied but correct	2
	Gives various but wrong answers	3
Originality	Give various and correct answers	4
	The procedure used is not a problem solving solution	1
	The method used is a problem solving solution, but what is used is a general solution	2
	The method used is not commonly used and was successful in solving the problem	3
Elaboration	The method used is different from the common ones and is exciting and successful in solving problems	4
	There is no explanation or provides little explanation so that it becomes less clear	0
	Inaccurate troubleshooting steps and incorrect results	1
	Problem solving steps are inaccurate, but the results given are correct	2
	The troubleshooting steps are accurate, but the results are incorrect	3
	Troubleshooting steps are accurate and provide correct results	4

The data analysis used in this research is multivariate analysis, namely Pillai's Trace, Wilks Lambda, Hotelling's Trace, and Roy Largest Root (Ilabaya et al., 2021; Ismiyanti, 2020). Multivariate analysis is the study of several variables in a data set. Multivariate tests are used to determine whether there are differences in critical and creative thinking skills based on the worksheets used in learning.

Because there are 4 tests used in this research to conclude that there are differences in critical and creative thinking skills based on the teaching materials used, it can be seen from the results that at least two multivariate tests obtained a significance coefficient of less than .05. Before carrying out a multivariate test, there are two assumptions that must be met, namely (1) the data comes from each population with a normal distribution, and (2) the variance and covariance matrices in the two populations must be the same (Budiyono, 2015b). The first assumption can be measured using normality tests, one of which uses the Kolmogorov-Smirnov test (Demir, 2022; Le Boedec, 2016; Razali & Wah, 2011). The second assumption can be measured using the homogeneity of variance test, one of which uses the Lavene test (Kim & Cribbie, 2018; Nordstokke et al., 2019).

Results

Based on research conducted in sample classes, data was obtained regarding students' critical thinking and creative thinking in mathematics learning from classes VII-A and VII-B at Junior High School Pembangunan Piyungan. Data was collected through a final test when the research was completed. The post-test questions are in the form of an essay with five questions.

The results of the descriptive analysis were obtained from multivariate statistical testing using SPSS 20. This statistical test aims to determine the effect of e-worksheets based on Tri-N principles give support to improve creative and critical thinking ability of students in learning mathematics. Data on critical and creative thinking abilities can be seen in Table 3.

Table 3. Statistical Descriptive Test Results

	Variable	Mean	Mean	Std. Dev.	Min	Max
Critical	e-worksheet based on Tri-N	28	46.071	3.6710	40.0	52.0
	ordinary e-worksheet	24	41.333	3.6555	36.0	48.0
	Total	52	43.885	4.3416	36.0	52.0
Creative	e-worksheet based on Tri-N	28	42.607	3.6346	37.0	48.0
	ordinary e-worksheet	24	39.833	3.7027	34.0	47.0
	Total	52	41.327	3.8893	34.0	48.0

The data presented in Table 3. shows that students' critical and creative thinking abilities getting better results on average using e-worksheets based on Tri-N principles than ordinary e-worksheets. This can be seen in the control group; the average critical thinking ability is 41.333, and the average creative thinking ability

is 39.833, while in the experimental group the average critical thinking ability is 46.071 and the average creative thinking ability is 42.607.

The collected data was analyzed first to the hypothesis before concluding. The hypothesis test used is a multivariate test. The condition for using a multivariate test is that the data must come from a ordinary and homogeneous population. The results of the posttest normality test for both groups using Kolmogorov-Smirnov are presented in Table 4.

Table 4. The Result of The Normality Test

Variable	Group	Kolmogorov-Smirnov		
		Statistic	df	Sig.
Critical	Experiment	.151	28	.104
	Control	.120	24	.200
Creative	Experiment	.137	28	.194
	control	.172	24	.063

Based on the SPSS results, the experimental class and control class show a sig value > 0.05, so it can be concluded that the data is normally distributed. All data for both groups is normally distributed, so the next prerequisite test is the homogeneity test. The homogeneity test of the two groups can be seen in Table 5.

Table 5. Result of Homogeneity Variance

Variable	Based on	Levene	df1	df2	Sig.
		Statistic			
Critical	Mean	.033	1	50	.858
	Median	.015	1	50	.904
	Median and with adjusted df	.015	1	49.617	.904
	trimmed mean	.039	1	50	.845
Creative	Mean	.061	1	50	.806
	Median	.003	1	50	.953
	Median and with adjusted df	.003	1	49.825	.953
	trimmed mean	.053	1	50	.820

In the data on creative and critical thinking skills, the sig value is more than 0.05 as shown at Table 5. So, it can be concluded that the variance of the two groups is homogeneous. After the prerequisite tests are completed and all the results meet the requirements, the next step is hypothesis testing. Multivariate test was conducted to the hypothesis test using SPSS. The calculation results can be seen in Table 6 and Table 7.

Table 6. The Result of the Multivariate Test

	Effect	Value	F	df of hypothesis	df of error	Sig.
Intercept	Pillai's Trace	.994	4030.991	2.000	49	.000
	Wilks' Lambda	.006	4030.991	2.000	49	.000
	Hotelling's Trace	164.530	4030.991	2.000	49	.000
	Roy's Largest Root	164.530	4030.991	2.000	49	.000
Worksheet	Pillai's Trace	.805	101.137	2.000	49	.000
	Wilks' Lambda	.195	101.137	2.000	49	.000
	Hotelling's Trace	4.128	101.137	2.000	49	.000
	Roy's Largest Root	4.128	101.137	2.000	49	.000

According to the data analysis in Table 6, the results of the multivariate test showed that $F_{count} = 101.137$ for Pillai's Trace, Wilks' Lambda, Hotelling's Trace, and Roy's Largest Root. Besides that, a significance coefficient of .000 was also obtained for all multivariate tests used in this research. This result indicates that the alternative hypothesis (H_1 is accepted). For this reason, the research results can be concluded that the e-worksheets used have different effects on critical and creative thinking skills.

Table 7 showed the research hypothesis test results and indicates that H_1 is accepted in all tests. In the hypothesis test, e-worksheets based on Tri-N influence on critical thinking skills can be seen at $F_{count} = 21.612$ with a significance coefficient 0.000. This research showed that using e-worksheets in mathematics learning affects essential thinking skills differently. In the hypothesis test, e-worksheets based on Tri-N influence on creative thinking skills can be seen in the $F_{count} = 7.398$ with a significance coefficient of 0.009. This research showed that using e-worksheets in mathematics learning affects creative thinking skills differently.

Table 7. Result of The Research Hypothesis Test

Source	Variable	Sum of square	df	Mean Square	F	Sig.
Corrected Model	Critical	290.117	1	290.117	21.612	.000
	Creative	99.430	1	99.430	7.398	.009
Intercept	Critical	98727.040	1	98727.040	7354.622	.000
	Creative	87830.815	1	87830.815	6534.915	.000
Worksheet	Critical	290.117	1	290.117	21.612	.000
	Creative	99.430	1	99.430	7.398	.009
Error	Critical	671.190	50	13.424		
	Creative	672.012	50	13.440		
Total	Critical	101106.000	52			
	Creative	89583.000	52			
Corrected Total	Critical	961.308	51			
	Creative	771.442	51			

Statistical calculations showed that using e-worksheets in mathematics learning has significant effects on critical and creative thinking abilities (see Tables 6 and 7). The e-worksheets used in this research are ordinary e-worksheets used for students who are members of the control group and e-worksheets based on Tri-N used for students who are members of the experimental group. To find out the better effect of e-worksheets on these two abilities can be done by comparing the averages obtained in the control and experimental groups. This technique can be used if only two groups are to be compared (Budiyono, 2015a, 2015b). Based on Table 3, it was found that in the control group, the average critical thinking ability was 41.333 and the average creative thinking ability was 39.833, while in the experimental group, the average critical thinking ability was 46.071 and the average creative thinking ability was 42.607. These averages indicate that the result of the experimental group was better than the control group in critical and creative thinking abilities. Therefore, it can be concluded that e-worksheets based on Tri-N principles have a positive effect to the creative and critical thinking ability of students in learning mathematics.

Discussion

Based on the SPSS results, it was found that Fcount in the critical area. So that e-worksheet based on Tri-N principles give improvement to creative and critical thinking ability of students in learning mathematics than learning through ordinary e-worksheets. It is assumed that the e-worksheet teaching materials use the Tamansiswa teaching principles called Tri-N, including *Niteni*, *Nirokke*, and *Nambahi*, in this study the experimental groups getting the better result than the control group. Tamansiswa Tri-N principles have been proofed to foster students

become creative, critical, and innovative (Istiqomah et al., 2021). Tri-N learning media can also increase the desire to learn mathematics at school (Lena, 2017).

One of the benefits using e-worksheets for learning mathematics is involving the activity to develop mathematical concepts and assist in finding new ideas (Syahputri et al., 2023). E-Worksheet Based on Tri-N principles can help students solve problems, analyze, find their learning, and learn independently (Sutanto et al., 2023). Learning process that requires essential activities, including ask questions, research, discoveries, and solving non-routine problems (Samura, 2019). The E-Worksheet based on Tri-N Principles allows students to experience the process and find ideas independently. Each Tri-N step in the e-worksheet was designed to improve students' critical and creative thinking skills. Students learn actively by creating mathematical concepts and ideas through observation, questions, gathering information, associations, and communication, which requires thinking skills (Nurhikmayati, 2019).

The weakness of using an ordinary e-worksheet in learning mathematics. An ordinary e-worksheet that used by students in control classes do not help improve students' critical thinking and creative thinking skills because these teaching materials do not contain steps to encourage students to develop their knowledge. In ordinary e-worksheets, only material and exercises are given, so teachers only teach what is in ordinary e-worksheets without allowing students to think critically and creatively. Most of mathematical textbooks are used less exciting and challenging for students to understand and build the concept independently (Indaryati & Jailani, 2015). This is because most mathematical textbooks use language that is difficult to understand and less attractive, making students feel bored (Muharni et al., 2021). Students who experience boredom and laziness can cause their critical and creative thinking abilities to be low (A. D. Mutia, 2023). To help students learn to think systematically, logically, and scientifically, teachers must strengthen their ability to facilitate learning.

Based on the test results, this research reveals that the mathematics teaching and learning process using e-worksheets based on Tri-N principles give critical and creative mathematical thinking skills. Appropriate e-worksheets can improve students' critical thinking skills and make classroom learning activities more systematic, effective, and efficient (Rismayanti et al., 2022; Soeyono, 2014). One of the mathematics teaching materials that can support learning mathematics to be more effective, active, and interactive is the using of Tamansiswa Tri-N Principles (Indriani & Sakti, 2022; Widiatmoko, 2022). Previous research showed that the using of Tamansiswa Tri-N Principles in e-worksheets can improve student learning outcomes (Widada, 2020; Wijayanti et al., 2021).

The results of this research are in line with the results of previous research, which stated that the use of E-Worksheet based on Tri-N principles can improve learning (Angraini et al., 2022; Aziza et al., 2019; M. S. A. Dewi & Lestari, 2020; Maharani et al., 2017; A. H. Nisa et al., 2020). The teaching materials can help students understand concepts and solve mathematics problems (Hasibuan et al., 2022; Rani Rahim et al., 2022; Susilawati & Zulfah, 2020).

Conclusion

This research showed the differences of using between E-Worksheet based on tri-n principles and an ordinary worksheet to improve creative and critical thinking ability of students in learning mathematics. This difference can be seen from statistical calculations using multivariate tests such as Pillai's Trace, Wilks Lambda, Hotelling's Trace, and Roy Largest Root. As a results, the SPSS output showed the average of E-Worksheet Based On Tri-N Principles get higher than an ordinary worksheet. For this reason, it can be concluded that e-worksheet based on Tri-N principles positively affect critical and creative thinking abilities compared to ordinary worksheets. This E-Worksheet contain Ki Hajar Dewantara Principles from Tamansiswa called Tri-N, including the *Niteni*, which means observing; *Nirokke* which means imitation; and *Nambahi* which means adding. For the results of this research, e-worksheets based on Tri-N principles can be recommended as an alternative mathematics learning media to improve critical and creative thinking skills.

This research focus on linear equations and inequalities topics through E-Worksheet based on Tri-N Principles. Therefore, it is possible to pursue further studies in other mathematical topics. Suggestion, it is also recommended to deep understanding the individual characteristics of research subject.

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