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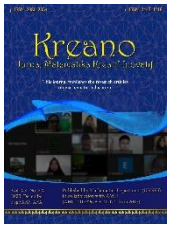

What kind of Relation and Function Worksheet Based Tri-N improve Critical Thinking Skills?

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Abstract

Mathematical critical thinking skills have so far shown unsatisfactory results, so media or learning resources such as worksheets are needed to complete them. In addition, concepts of scientific learning such as Niteni, Nirokke, and Nambahi activities have not provided opportunities for students to think critically. For this reason, this study aims to obtain valid and practical relations and function worksheets based on tri-n. The research stages used are defining, designing, and developing. These three stages are part of the development research with 4D. At the defining stage, data collection techniques use documentation to make the data analysis qualitative. At the design stage, data collection techniques use observation to make the data analysis qualitative descriptive. In the developing stage, the data collection technique uses a questionnaire, so the data analysis is quantitative. The results showed that the relations and function worksheets based on Tri-N had a V-Aiken index of more than 0.83, and some students responded well to this worksheet. Apart from that, the mathematics material in this Student Worksheet uses the Tri-N stages, namely Niteni, Nirokke, and Nambahi. Based on this, it can be concluded that the Tri-N-based Student Worksheet on Relations and Functions is a valid and practical result of development. For this reason, this worksheet can be used to improve students' critical thinking skills.

Keywords: Critical Thinking; Niteni; Nirokke; Nambahi; Worksheet.

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Abstrak

Kemampuan berpikir kritis matematis siswa selama ini menunjukkan hasil yang belum memuaskan, sehingga dibutuhkan media atau sumber belajar sepert worksheet untuk menyelesaikannya. Selain itu, konsep pembelajaran saintifik seperti kegiatan Niteni, Nirokke, Nambahi belum memberikan kesempatan kepada siswa untuk berpikir kristis. Untuk itu penelitian ini bertujuan untuk memperoleh Lembar Kerja Siswa Relasi dan Fungsi berbasis Tri-N yang valid dan praktis. Tahapan penelitian yang digunakan adalah mendefinisi, mendesain, dan mengembangkan. Ketiga tahapan ini merupakan bagian dari penelitian pengembangan tipe 4D. pada tahap mendefinisi, Teknik pengumpulan data menggunakan dokumentasi, sehingga analisis data yang digunakan bersifat kualitatif. Pada tahap mendesain, Teknik pengumpulan data menggunakan observasi, sehingga analisis data yang digunakan bersifat kualitatif deskriptif. Tahap mengembangkan, Teknik pengumpulan data menggunakan angket, sehingga analisis data yang yang digunakan bersifat kuantitatif. Hasil penelitian diperoleh bahwa Lembar Kerja Siswa Relasi dan Fungsi memiliki indeks V Aiken lebih dari 0,83, dan sebagian siswa memberikan respon sangat baik terhadap prototipe worksheet ini. Selain itu, materi matematika yang ada pada Lembar Kerja Siswa ini menggunaan tahapan Tri-N, yaitu Niteni, Nirokke, dan Nambahi. Berdasarkan hal tersebut dapat disimpulkan bahwa Lembar Kerja Siswa Relasi dan Fungsi berbasis Tri-N hasil pengembangan yang valid dan praktis. Untuk itu dimungkinkan worksheet ini digunakan sebagai salah satu cara untuk meningkatkan kemampuan beprikir kritis siswa.

INTRODUCTION

Mathematics education contains many connections with real life, presented verbally and visually with pictures, photos, diagrams and other visualizations. The context is drawn from a broad spectrum of real-life areas, reflecting that mathematics can be found everywhere in society (Wijers & de Haan, 2020). However, mathematics is a complicated subject, a whole of formulas and numbers. Students also think that mathematics is unrelated to everyday life, so students' interest in learning mathematics is often in the low category (Pratama et al., 2018) even though mathematics is an important subject that needs to be studied because it underlies other subjects and plays an essential role in all aspects of life, especially in improving human thinking power (Indiyah et al., 2021).

The teachings of *Niteni*, *Nirokke*, and *Nambahi*, often referred to as Tri-N, are Tamansiswa teachings that originate from the thoughts of Ki Hadjar Dewantara (Ardhyantama, 2020; Nisa et al., 2019). The concept of the Tri-N approach is in line with the scientific approach, where this learning provides opportunities for students to actively observe, ask questions, collect data, as well as associate and communicate (Anafiah & Hangestiningsih, 2019; Istiqomah et al., 2021; Wijayanti, 2018). In contrast to APOS, which emphasizes the knowledge framework formed from a person's cognitive processes starting from interiorization, coordination/retrieval, and encapsulation/deencapsulation so that the schema always remains in everyone (Firdaus et al., 2023; Irfan et al., 2020), Tri-N places more emphasis on the syntax of learning that must be passed through, in the learning process (Ermawati & Rochmiyati, 2020).

Niteni is a student activity that is characterized by careful use of the five senses, where through this observation, detailed/specific and in-depth information is obtained and linked to students' prior knowledge (Damayanti & Rochmiyati, 2019; Istiqomah et al., 2021). *Niteni* is a cognitive process or human mind derived from the word "*titen*" (Nisa et al., 2019; Wijayanti et al., 2022). *Niteni* or *titen* refers to the ability to carefully recognize and capture the meaning (nature, characteristics, procedures, truth) of an object being observed by paying attention, comparing, scanning, observant and deep and involving all the senses (Nisa et al., 2019).

Nirokke, or imitating, is the nature of childhood. Behavior imitates models or

examples from teachers or learning resources (Rochmiyati & Putro, 2020; Wijayanti et al., 2021). *Nambahi* is or is a continuation of the *Nirokke* (Andayani et al., 2021). In this process, there is a creative and innovative process to give new colours to the imitating model. *Nirokke* is very useful for students because it has the nature of self-education through orientation and experience (Nita et al., 2017). *Nirokke* is not wrong, but duplicating or imitating models, methods, enthusiasm, and management is helpful for students to absorb the information provided by the teacher (Wijayanti & Utaminingsih, 2017). Learning Nirokké can be done by modelling or copying other people's behaviour (teachers, friends, society, etc.) to develop knowledge and learning experiences.

Nambahi means adding or can be translated as imitating by developing (Sibyan et al., 2019). The *Nambahi* activity is a follow-up activity after *Nirokke*. This *Nambahi* activity is expected to happen to students, so they do not just imitate or duplicate the information the teacher has received. So, in acquiring new knowledge, students do not just imitate the information provided by the teacher but also must process the information they obtain. In the *Nambahi* process, of course, there is a creative and innovative process to provide new nuances to the model being imitated (Herawati, 2019; Rozak & Wardina, 2014) so that we do not just imitate but improve, add, reduce, change and process something that is replicated.

The results of previous research show that implementing the Tri N concept can foster a creative spirit, build an attitude of honesty, discipline, hard work, creativity, independence, and curiosity, and develop abilities in participants (Nisa et al., 2019; Novika & Harahap, 2018). This concept can be viewed as a learning theory (Nita et al., 2017). The Tri-N concept from Ki Hajar Dewantara can also be said to be a technique in learning (Rozak & Wardina, 2014). These studies show that Tri-N affects the learning outcomes that students must have. Besides that, many studies have implemented the Tri-N concept in mathematics learning. Such as learning Integral material using Tri-N and YouTube media (Wigati et al., 2018) and improving learning outcomes in junior high school of Muhammadiyah 2 Depok class IX students in 2019/2020 using the Tri-N concept assisted by structured worksheets on number material (Widada, 2020). Jigsaw Learning with Tri-N will increase mathematics activity and learning outcomes in class VII students at junior high school in Banguntapan (Pramudya & Harini, 2020). This shows that Tri-N can be used as an alternative to learning mathematics. Even though the tri-N learning that has been carried out cannot stand alone, it must involve other aspects such as learning models, learning media, teaching materials and worksheets (Ermawati & Rochmiyati, 2020; Holis, 2017; Pramudya & Harini, 2020; Wijayanti et al., 2021).

The worksheet is a student guide used to carry out investigative and problem solving activities and contains activities that students must carry out (Hayati et al., 2016; Prabawati et al., 2019; Purwasi & Fitriyana, 2019). This causes worksheets to be seen as learning media and a learning resource (Astuti et al., 2017; Priyambodo et al., 2012). Both as a medium and as a learning resource, the ultimate goal of the worksheet is to assist students in maximizing their understanding and abilities through the learning achievements that must be taken.

Many researchers have carried out research related to worksheets with student abilities. Such as the effect of the worksheet on the ability to solve problems (Ichsan et al., 2023; Widodo et al.,

2023), the impact of the worksheet on the ability to think creatively (Aripin & Purwasih, 2017; Islamiyati et al., 2023; Purwaningsih et al., 2021), worksheet effect on mathematical communication skills (Ismail et al., 2020; Riyati & Suparman, 2019), the impact of worksheets on critical thinking skills (Fernando et al., 2021; Hayati et al., 2016; Ningrum et al., 2022). The results of this study indicate that worksheets have a potential effect on improving students' abilities. However, the study results show that students' soft and hard skills are still not optimal. As previously reported, students' critical thinking skills are still low (Agnafia, 2019; Nuryanti et al., 2018; Priyadi et al., 2018). At the same time, thinking critically is thinking logically and systematically when deciding or solving a particular problem (Murni et al., 2022; Nuryanti et al., 2018; Wulansari et al., 2019). For this reason, it is necessary that worksheets can be used as an alternative media or learning resource so that students' cognitive abilities, such as students' mathematical critical thinking skills, can increase.

In this regard, the objectives to be achieved from this research include finding out the validity, practicality and effectiveness of Tri-N based worksheets on relations and functions to improve the critical thinking skills of junior high school students. The material for relations and functions was chosen in the development of this worksheet because this material is one of the subject matters of mathematics studied by students in grade VIII of junior high school and one of the basic materials for entering the following material such as limits of functions, derivatives and others (Lesiana & Hiltrimartin, 2020; Melani & Sutirna, 2020; Septianti, 2020). In addition, the results of the preliminary study conducted earlier found that the ability of junior high school students to understand the material on relations and functions stated that students still lacked mastery of the problems faced. Most students considered the questions to be difficult, students were less enthusiastic about understanding the questions, and students also felt confused about solving the questions given (Anggraini et al., 2021; Martha & Reni, 2022; Pendy & Mbagho, 2021).

METHOD

In accordance with the objectives of this research, the stages of this research are defined, designed, developed, and disseminated (Thiagarajan et al., 1974). Four steps on 4D are divided into nine main activities: curriculum analysis, Tri-N analysis, Analysis of critical thinking skills, learning objective, prototype of worksheet, validation Expert, development testing, validation testing, packaging, diffusion and adoption (see Figure 1).

The define stage is carried out to determine, define and analyze the needs of the product to be developed (Thiagarajan et al., 1974). The product to be designed in this research is the Relation and Function Worksheet Based Tri-N. The needs analysis includes (1) curriculum analysis, (2) Tri-N analysis, and (3) analysis of critical thinking skills. For this reason, at this early stage, the researcher did not test the hypothesis but focused on the development needs analysis activities and the requirements for product development according to user needs (in this case, the needs of teachers and students in junior high school).

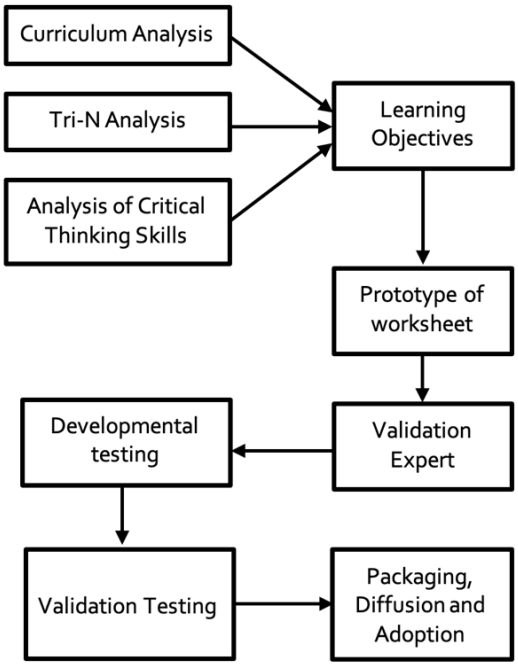


Figure 1. Research Stages

At the design stage, a product development format is developed (Thiagarajan et al., 1974). It is intended that the initial design of the product in the form of a Relation and Function Worksheet Based on Tri-N has an overview. At this stage, it is expected to have an effect as a Relation and Function Worksheet Based Tri-N prototype.

The development stage consists of two things that must be done: expert validation and developmental testing (Thiagarajan et al., 1974). At the expert validation stage, it is carried out to determine the quality of the prototype of relation and function worksheet based Tri-N that has been designed based on aspects (a) design and layout of the worksheet, (b) mathematical content, (c) Tri-N content, and (d) language. Developmental testing activities are carried out to determine student responses to the relation and function worksheet prototype based on Tri-N to increase students' critical thinking skills. Trials of prototype relation and function worksheet based tri-N given to class 8 students of Junior High School. The results obtained in this trial were in the form of student responses received from filling out a questionnaire conducted by students.

The last stage, or dissemination stage, aims to promote the product developed to be accepted by individual users. The dissemination stage has three main steps: validation testing, packaging, diffusion, and adoption (Thiagarajan et al., 1974). In the validation testing stage, the product revised at the development stage is implemented on the actual target or target. This activity aims to determine the effectiveness of the product being developed; in this case, the product's effectiveness is seen from the students' critical thinking abilities. The packaging stage is carried out by printing a worksheet. This worksheet is published so that others can diffuse and adopt the product.

The data collection method in this study was adapted to the stages of the research. The define stage is done with documentation. The documentation at this stage is in the form of a *Merdeka* curriculum policy such as Minister of Education, Culture, Research and Technology Regulation No. 262/M/2022, and Decree of the Head of Education Standardization, Curriculum and Assessment Agency Number 033/H/KR/2022. In addition, other documentation, such as study results published by researchers and accessed online, is also used at the define stage. At the design stage, data collection was carried out using observation. Researchers are designing prototype products of relation and function worksheets based on Tri-N.

At the development stage, data collection techniques are carried out by means of a questionnaire. The questionnaire used at this stage is a validation sheet that experts must fill out. This questionnaire evaluates the prototype of the Relation and Function Worksheet Based Tri-N designed in the previous step. Vali-

dation questionnaires were given to experts, in this case, practitioners and academics. Practitioners used as experts at the validation stage were junior high school mathematics teachers, while the academics used as experts in the validation stage were lecturers in mathematics education. In addition to the validation questionnaire, a student response questionnaire was used to operate the prototype relation and function worksheet based on Tri-N. This response is used to see the readability of the worksheet designed in the previous stage.

At the dissemination stage, data collection techniques are carried out by means of tests. This test is used to determine students' critical thinking abilities. The critical thinking ability test assessment indicators refer to the scoring rubric from Ismaimuza (2013), Facione (1992), Rosliani & Munandar (2022), and Kurniasih et al. (2020), namely Interpretation, Analysis, Evaluation and inference. More details can be seen in Table 1.

Qualitative descriptive data analysis techniques were used for the define and design stages. Data analysis techniques using descriptive qualitative methods are carried out by 1) preparing and organizing data for analysis, (2) exploring and coding data, (3) coding to build descriptions, (4) representing and reporting findings, (5) interpreting results, and (6) validate the accuracy of the findings (Creswell, 2012).

At the development stage, quantitative data analysis is carried out. The data obtained from the validator is then analyzed using the Aikens Formula (Aiken, 1980, 1999; Aiken & Patrician, 2000), as follows:

Table 1. Mathematical thinking ability assessment rubric

INDICATOR	INFORMATION	SCORE
Interpretation	Students do not write down what is known and what is asked	0
	Students write down what they know and what they ask, but it is not quite right	1
	Students write only what is known or what is asked	2
	Students write down what they know from the question, but it is not quite right	3
	Students write and ask questions ultimately and accurately	4
Analysis	Students do not create mathematical models from the problems given	0
	Students make mathematical models from the questions given, but they are not quite right	1
	Students create mathematical models from the questions given correctly without providing explanations	2
	Students create mathematical models from the questions given correctly, but there are errors in the explanation	3
	Students create mathematical models of the questions given correctly and provide correct and complete explanations	4
Evaluation	Students do not use strategies to solve problems	0
	Students use incomplete and inappropriate strategies in solving problems	1
	Students use strategies in solving problems that are incomplete or use strategies that are incomplete but complete in solving problems	2
	Students use appropriate and complete strategies in solving problems but make errors in calculations or explanations	3
	Students use appropriate, complete and correct strategies in solving problems	4
Inference	Students do not make conclusions	0
	Students make conclusions, but they are inaccurate and not appropriate to the context of the problem	1
	Students make conclusions, but they are not correct even though they fit the context of the question	2
	Students make conclusions correctly, according to the context of the question, but are not complete	3
	Students make conclusions wholly and correctly according to the context of the problem	4

$$eV = \frac{\sum s}{n\ (c-1)}$$

With,

eV = *rater agreement index*
n = *the number of raters*
S = *the score set by each rater minus the lowest score in the category used* $(r - l_0)$
l_0 = *lowest validity rating score*
c = *the highest validity rating score*
r = *the number is given by the validator*

This formula determines how far the Tri-N Based Relation and Function Worksheet prototype is valid. The rater agreement index statistically ranges from 0 to 1. The number of raters (in this case, the appraisers) used in this study was six people. The validity criteria were determined from the validity index obtained and then compared with the Aiken V Index table. For the number of raters 6 in Table V Aiken received 0.78 (Aiken 1985). For this reason, a product is said to be valid for each item if the Aiken V Index is calculated to be more than 0.78.

The data obtained from student responses is collected by looking at the percentage of answers given by students for each aspect of the total number of students. Student response to the prototype product relation and function worksheet based Tri-N refers to the Likert scale, namely efficient with a score of 5, practical with a score of 4, less practical with a score of 2, and impractical with a score of 1. Furthermore, the results of the percentage of student responses obtained for each indicator, the average is determined and grouped into very practical, practical, less practical, and impractical, as can be seen in Table 2 (Afifah et al., 2021; Ikram et al., 2021).

Table 2. Practical level category

No	Percentage (P)	Category
1	$75 \leq P \leq 100$	very practical
2	$50 \leq P < 75{,}0$	practical
3	$25 \leq P < 50$	Less practical
4	$0 \leq P < 25{,}0$	impractical

The results of this percentage indicate the practicality of a product resulting from its development (Ardianti et al., 2019; Annisa et al., 2022). Where the prototype relation and function worksheet based on Tri-N is considered practical, at least 50% of students say it is very practical.

At the dissemination stage, data is obtained at the validation testing stage. Because, at this stage, the aim is to determine the effectiveness of the LKPD product in terms of students' critical thinking abilities, data on this ability was obtained from the pre-test and post-test. To see its effectiveness, data analysis uses N-Gain (Aziz et al., 2021; Hake, 1998), namely

$$N - Gain = \frac{Post\ test\ Score - Pre\ tes\ Score}{Ideal\ Score - Pre\ tes\ Score}$$

Analysis carried out on the results of the interpretation of the N-gain value criteria (Hake, 1998; Trisniawati et al., 2019) is shown in Table 3.

Table 3. N-Gain Score Interpretation

Score	Interpretation
$N - Gain < 0.30$	Low
$0.30 \leq N - Gain \leq 0.70$	Mediun
$N - Gain > 0.70$	High

The effect size e-Worksheet uses Cohen's d formulation (Goulet-Pelletier & Cousineau, 2018; Lakens, 2013; Maher et al., 2013) as follows:

$$ES = \frac{M_{diff}}{\sqrt{\frac{\sum (X_{diff} - M_{diff})^2}{N-1}}}$$

With,

ES = *effect size*
M_{diff} = *the mean of the difference between post-test and pre-test data*
X_{diff} = *difference between posttest and pretest data*
N = *sample size*

Analysis of the results of the interpretation of the effect size criteria (Cohen et al., 2007; Yunita et al., 2021) is presented in Table 4.

Table 4. Effect Size Interpretation

Effect Size	Interpretation
$0.00 \leq ES < 0.20$	Ignored
$0.20 \leq ES < 0.50$	Small
$0.50 \leq ES < 0.80$	Fair
$0.80 \leq ES < 1.30$	Large
$ES \geq 1.30$	Very large

RESULT AND DISCUSSION

Results

The stages carried out in this study are defining, designing, developing, and disseminating. The results of this study for each stage are presented in the following explanation.

Define

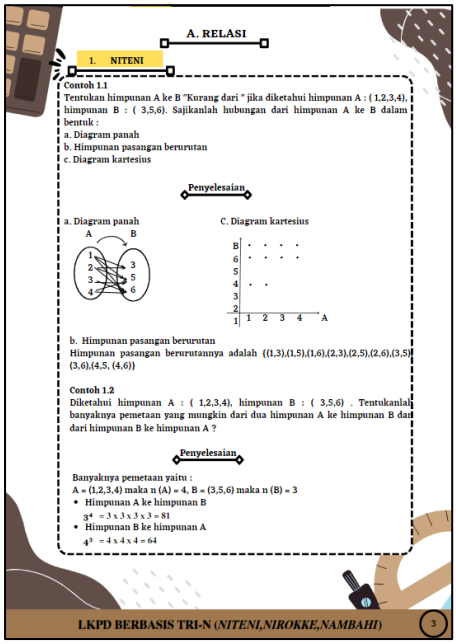
In the define stage, it is carried out to analyze needs related to (1) curriculum analysis, (2) Tri-N analysis, and (3) analysis of critical thinking skills. At this stage, it is not carried out to test a hypothesis, but it is focused on needs analysis activities and product development requirements tailored to user needs (Thiagarajan et al., 1974).

Curriculum analysis is done by dissecting learning outcomes in the independent Relation and Function material curriculum. This curriculum review is carried out to determine the suitable material about relations and function. A decree number 033/H/KR/2022 issued by Agency of Standardization, Curriculum, and Assessment of Education (*Badan Standarisasi, Kurikulum, dan Asesmen Pendidikan)* found that the Relation and Function material included in the algebraic elements with the learning outcomes being students can understand relations and functions (domain, codomain, range) and present it in the form of arrow diagrams, tables, sets of ordered pairs, and graphs. From the learning outcomes of this study, the material on relations and functions consists of relationships, functions, and mappings; the characteristics of relations and functions; formulas of functions; graphs of functions; and problem-solving related to relations of function.

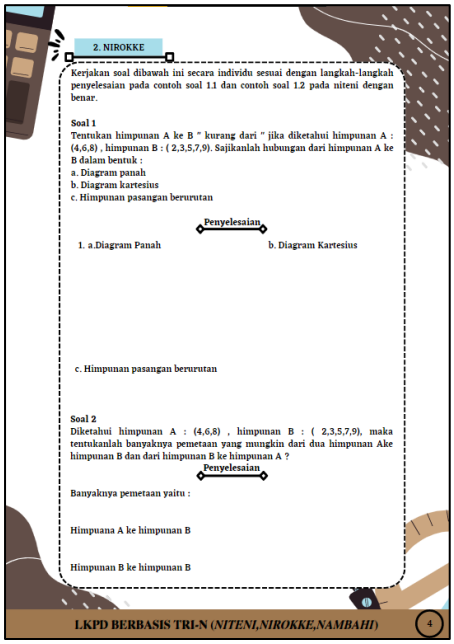
Tri-N is a learning activity that aligns with the scientific approach, using the *niteni*, *nirokke*, and *nambahi* stages (Damayanti & Rochmiyati, 2019; Wigati et al., 2018). The Tri-N analysis is carried out by reviewing published articles that can be accessed through Google Scholar. The results of the review of published articles obtained indicators for the stages of Tri-N. *Niteni* is an activity that involves marking by paying close attention and using all the senses (Damayanti & Rochmiyati, 2019). In this *niteni* activity, it is also a process of seeking and finding meaning (nature, characteristics, procedures, truth) of an object of safety from the five senses (Wijayanti et al., 2021; Wijayanti et al., 2023). Niteni activities can include listening to teacher explanations and conducting literature reviews by identifying reading content through the 5W + 1H formula (Anafiah & Hangestiningsih, 2019).

Nirokke is an activity of imitating what is taught through models/examples/examples from teachers/learning resources by involving the mind, senses, feelings/conscience, and spirituality integrally and harmoniously (Ermawati & Rochmiyati, 2020; Rochmiyati & Putro, 2020). *Nambahi* adds or subtracts what he has learned to develop his creativity and ideas by utilizing learning resources (Hidayati & Khasanah, 2020; Rochmiyati & Putro, 2020).

Critical thinking skills analysis shows



(a)



(b)

Figure 2. Display of Relation and Function worksheet based Tri-N

that this ability's indicators include interpretation, analysis, inference, explanation, and self-regulation (Agnafia, 2019; Rositawati, 2019; Ariq & Fitrihidajati, 2021). However, some research results suggest that indicators of mathematical critical thinking ability include (1) the ability to give reasons for mastering concepts and justifying concepts, (2) the ability to complete supporting data or information, and (3) the ability to evaluate or examine an algorithm (Buhaerah, 2016; Rahmasantika & Charitas, 2022; Zetriuslita et al., 2016). In addition, several research results have shown that mathematical worksheets affect or influence students' mathematical critical thinking skills. Therefore, if students' critical thinking skills are not optimal, one way to improve this ability is to use a mathematical worksheet.

Design

Learning outcomes have been determined on relations and functions at the defined stage. These learning outcomes refer to decisions of the head of the Agency of Standardization, Curriculum, and Assessment of Education number 033/H/KR to design a mathematical worelationon Refunctionnd Functiowill be designed n material to improve junior high school students' critical thinking skills.
The design of this mathematical worksheet aims to improve junior high school students' critical thinking skills so that one of the elements of the Pancasila student profile, namely critical reasoning, can be achieved. For this reason, the design of this mathematical worksheet includes mathematical problems that can stimulate students to think critically. Several views of relations and Functions worksheet based Tri-N can be seen in Figure 2.

Develop

Two activities are carried out at the development stage: expert validation and developmental testing (Thiagarajan et al., 1974). The goal of these two stages is to see the validity of the Relation and Function product prototype worksheet bai-N in theoretical and empirical terms. Thus, the prototype relation and Function worksheet based on Tri-N could be a hypothetical product ready to be tested on a large

scale.

The validation expert activity involved three mathematics education lecturers and three junior high school mathematics teachers. Their involvement at this stage is to become a validator whose job is to provide assessments, suggestions, and criticism product of the Relation and Function worksheet based on Tri-N. The Tri-N worksheet based Relation and Function product assessment refers to indicators (1) design and Layout, (2) mathematical content, (3) Tri-N content, and (4) language.

In the design and layout indicators, it consists of 6 sub-indicators, namely (1) initial appearance (cover), (2) font type and font size, (3) figure, (4) colour and appearance, (5) the attractiveness of the worksheet, and (6) the identity of the author. The validation results on this indicator can be seen in Table 5.

Table 5. Feasibility Assessment Results on Design and Layout Aspects

No	Indicators	*eV*	Conclusion
1	initial appearance (Cover)	1,00	Valid
2	font type and font size	0,94	Valid
3	figure	0,83	Valid
4	colour and appearance	0,83	Valid
5	the attractiveness of the worksheet	1,00	Valid
6	identity of the author	1,00	Valid

Based on Table 5, it can be concluded that the prototype of the Mathematical Worksheet on the relation and function is valid for indicator design and layout. This is because all the items asked for in the design and layout indicators have an Aiken validity index of more than 0.78.

In the mathematical content indicator, it consists of 7 sub-indicators, namely (1) suitability of the material with learning outcomes, (2) suitability of the material with practice questions, (3) completeness of the material, (4) suitability of learning objectives and activities, (5) material presentation system, (6) worksheets facilitate students to think critically, and (7) use of media. The validation results on this indicator can be seen in Table 6.

Table 6. Feasibility Assessment Results on Design and Layout Aspects

No	Indicators	*eV*	Conclusion
1	Suitability of the material with learning outcomes	0,94	Valid
2	Suitability of the material with practice questions	1,00	Valid
3	Completeness of the material	1,00	Valid
4	Suitability of learning objectives and activities	0,83	Valid
5	material presentation system	0,94	Valid
6	Worksheets facilitate students to think critically	0,94	Valid
7	Use of media	0,83	Valid

Based on Table 6, it can be concluded that the prototype of Mathematical Worksheet Relation and Function is valid for indicator mathematical content. This is because all the items asked for in the mathematical content indicator have an Aiken validity index of more than 0.78.

The Tri-N content indicator consists of 4 sub-indicators, namely (1) the initial display shows Tri-N, (2) the worksheet contains the Tri-N stages, (3) Materials and learning activities according to the tri-N stages, and (4) the worksheet invites students to do the Tri-N stages. The validation results on this indicator can be seen in Table 7.

Table 7. Results of the Feasibility Assessment on the Aspect of Tri-N Content

No	Indicators	*eV*	Conclusion
1	The initial display shows Tri-N	1,00	Valid
2	The worksheet contains the Tri-N stages	1,00	Valid
3	Materials and learning activities according to the tri-N stages	0,83	Valid

No	Indicators	*eV*	Conclusion
4	The worksheet invites students to do the Tri-N stages	1,00	Valid

Based on Table 7, it can be concluded that the prototype mathematical Worksheet in material relation and function is valid for indicator Tri-N content. This is because all the items asked for in the Tri-N content indicator have an Aiken validity index of more than 0.78.

The language indicator consists of 2 sub-indicators, namely (1) use of language and (2) use of terms and symbols. The validation results on this indicator can be seen in Table 8.

Table 8. The results of the feasibility assessment on the language aspect

No	Indicators	*eV*	Conclusion
1	Use of language	0,83	Valid
2	use of terms and symbols	0,83	Valid

Based on Table 8, it can be concluded that the prototype mathematical Worksheet in material relation and function is valid for indicator language. This is because all the items asked for in the indicator language have an Aiken validity index of more than 0.78.

In addition to conducting a quantitative assessment, the validators provide qualitative assessments. The qualitative assessment they carried out was in the form of giving criticism and suggestions related to relations and function worksheet based Tri-N. The summary of recommendations and criticisms on the product of relation and Function worksheet based on Tri-N provided by the validator can be seen in Table 9. From these suggestions and criticisms, the next researcher can determine the follow-up strategy that must be carried out to improve the relation and function worksheet based on Tri-N.

Relation and Function worksheet based Tri-N, which has been repaired based on suggestions from validators, then a limited scale trial (small trial) was conducted to 10 junior high school students selected purposively. This trial aims to obtain responses or student responses to relation and function worksheet based Tri-N. Reactions from students were received by giving questionnaires with indicators of worksheet display, presentation of material, student attractiveness and product usefulness. The worksheet display indicator consists of 3 statement

Table 9. Suggestions and Follow-Up Plans

No	Suggestion	Follow-Up
1	In making an arrow diagram, it is better to write down sets of A and B; don't forget to write them because students will get confused.	The letters A and B are added to the arrow diagram to make it easier for students to get to know a set of A and a set of B.
2	In typing a rank number, it must be made like AB, not classified as A, to the power of B.	We are changing and retyping the correct way to type epaulettes in questions.
3	Determine the choice of words in making questions, and don't forget to always pay attention to writing so there are no typos.	Change the choice of words that have been suggested and be more careful in making questions so that there are no typos.
4	The arrangement of letters on the worksheet is given space	Change the order of notes on the worksheet so that there is room for students to write on the worksheet.
5	For pictures on the worksheet, you can colour them to make them more attractive, not just on the edges.	The images in the worksheet have been changed and coloured to make them more attractive to students.
6	In the subsequent development, to make the worksheet even better.	It was fixed in subsequent developments to make it more attractive.

items, the material presentation indicator consists of 7 statements, the attractiveness indicator consists of 2 comments, and the product usability indicator consists of 3 statements. The results of these student responses can be seen in Table 10.

Table 10. Percentage of Small Trial Results to Student Responses

No	Assessment Aspects	Percentage			
		5	4	2	1
1	Appearance	73,33	26,66	--	--
2	Material Presentation	57,14	42,85	--	--
3	Attractiveness	55,00	45,00	--	--
4	Usefulness	63,33	36,66	--	--
	average	62,20	37,80		

Based on Table 10, the students' responses to relation and function worksheet based Tri-N obtained an average of 62.28 very agree and 37.79 very agree. For this reason, it can be concluded that in small-scale trials, the relation and function worksheet-based Tri-N has a positive response from students to improve their ability to think critically.

Disseminate

The three main activities that must be carried out at the dissemination stage are (1) validation testing, (2) packaging, and (3) diffusion and adoption (Thiagarajan et al., 1974). The validation testing activity aims to determine the effectiveness of the product being developed. In this case, the efficacy of the relation and function worksheet based on Tri-N is seen in the students' critical thinking abilities. At this stage, the research design uses a one-group pretest-posttest method with a sample size of as much as possible. Pre-tests and post-tests are carried out to obtain students' critical thinking skills. The description of critical thinking ability data can be seen in Table 11.

Table 11. Description of Pre-test, Post-test and N-Gain data on critical thinking skills

Critical Thinking Skills	Interpretation		
	N	Mean	Variance
Pre-test	28	20.68	46.89
Posttest	28	36.11	63.65
N-Gain	28	0.53	0.13

Based on the results of N-gain calculations, it was found that the average N-gain was 0.53 with a variance of 0.13 (see Table 11). These results show that the average N-Gain meets the medium criteria. Calculating the effect size using Cohen's formula also showed that the ES was 1.37. These results indicate that the effect size is at very large standards. From the results of the N-Gain and effect size calculations that have been carried out, it can be concluded that the product influences critical thinking skills in a very large category. This shows that the development of relation and function worksheet based Tri-N is effectively used in learning.

In the packaging, diffusion, and adoption stages, the Tri-N-based LKPD relations and functions are packaged in open access, which can be seen on Google Drive with the link https://bit.ly/RelationFunctionWorksheet. In the long term, this LKPD will be placed in https://math-projejct.pmat.ustjogja.ac.id. This aims to ensure that mathematics teachers are in phase D, and students or other researchers in the field of mathematics education can access this product easily.

Discussion

Worksheets are student guides for investigative or problem-solving activities (Hayati et al., 2016; Riyati & Suparman, 2019; Tsani et al., 2019). The worksheet contains a set of essential activities that students must carry out to maximize understanding and as a form of effort to improve critical thinking skills through the achievement of the learning outcomes

pursued (Wahyuningsih, 2019; Setiawati et al., 2015; Roemintoyo & Budiarto, 2021). The components of the worksheet at least contain identity and cover, study instructions, learning competencies to be achieved or learning outcomes, learning achievement indicators, supporting information, tasks and work steps, assessments, and references or bibliography (Sakur et al., 2023; Saraswati & Salsabila, 2021).

Worksheets are a learning resource that can be developed by teachers who act as facilitators in learning activities (Sugiarto & Hidayah, 2019; Widodo et al., 2023). The worksheet development is expected to be used as a learning resource for students (Agustin et al., 2019; Septian et al., 2019) so that they get materials and directions indirectly from the teacher. Using worksheets, students are expected to experience a learning process in understanding the concepts being studied (Sumaryati & Husanah, 2015). Worksheets can be arranged and developed according to the conditions and situations of the learning activities (Listiani, 2018; Halija et al., 2021). Worksheet based Tri-N use the stages of niteni, nirokke and nambahi. These three Tri-N stages explicitly appear in the worksheet so that students can easily observe, imitate, and add to the knowledge they have received during their learning (Ardhyantama, 2020).

By the definition of a worksheet, namely a sheet that contains guidelines for students to carry out their learning activities, it is hoped that the use of worksheets in learning can measure the extent to which students can understand the material being studied. For Worksheet based Tri-N, students can use the learning materials and functions at the core learning activity stage. Core learning activities are the main activities in the learning process or the process of mastering students' learning experiences. These worksheets can shape students' learning experiences and abilities as planned by the teacher, and students can observe, imitate and then add to the knowledge they have received.

Prototype assessment results of relation and function worksheet based Tri-N conducted by six validators obtained that the indicator design and Layout, mathematical content, Tri-N content, and language have a V-Aiken index of more than 0.83. Even though the Vaiken index for six validators is expected to have a V Aiken index of at least 0.73 (Aiken 1985), for this reason, it can be concluded that the prototype of relation and function worksheet based Tri-N is valid in terms of design and layout, mathematical content, Tri-N content, and language.

In addition, in a limited scale trial conducted onteno purposively selected junior high school students, it was found that most students stated that relation and function worksheet based Tri-N is very good in appearance, presentation of material, attractiveness, and usability.

The two interpretations obtained based on the validation results and the results of limited-scale trials show that the worksheet prototype developed is suitable for use in the following research stage: large-scale trials or the dissemination stage. Based on expert judgment, the worksheet obtained an Aiken index of more than 0.83, and some students responded very well to the worksheet prototype developed.

The results of this study indicate that the worksheet has the function of activating students in the learning process, mainly active in communication skills and involved in conveying opinions or ideas both in writing and verbally (Ika, 2018; Diasanti & Rosdiana, 2019; Khikmiyah, 2021). In addition, the worksheet makes it easier for teachers to do learning. For stu-

dents, it is hoped that they can adapt independently to the material provided by the teacher (Irmeilyana et al., 2022).

By using a worksheet, it is suspected that students are more active in the learning process (Ginting & Ammy, 2022; Wewe & Bhoke, 2022), help in developing mathematical concepts (Effendi & Aini, 2018), practice discovering and developing process skills (Umbaryanti, 2016), as a guide for educators and students in carrying out the process of learning mathematics (Widada, 2016), The mathematical approach plays a vital role in helping students improve their abilities such as critical thinking skills (Rosita, 2014). This aligns with the results of other studies, which state that worksheets created using a mobile learning-based guided inquiry approach can theoretically optimize mathematical critical thinking skills (Sadiyyah et al., 2019). In addition, ethnomathematics-based worksheets with the STEM approach are effectively used to improve students' critical thinking skills (Novitasari et al., 2022). The results of developing worksheets based on discovery learning are valid, very practical and effective in learning mathematics to improve critical thinking skills (Murni et al., 2022).

The most striking difference between the current research and the research done so far is the worksheet approach used. In this study, the worksheet uses the approach of Tri-N and the material of relation and function. The relation and function worksheet contains straightforward content of the Tri-N Steps (*Niteni*, *Nirokke*, *Nambahi*) because every step is written in the worksheet. In contrast to previous research, such as worksheets with a guided inquiry approach based on mobile learning (Sadiyyah et al., 2019), ethnomathematics-based worksheets with a STEM approach (Novitasari et al., 2022), worksheets based on discovery learning (Murni et al., 2022).

As is known, Tri-N is a learning stage (syntax) that must be passed during the learning process (Herawati, 2019; Nisa et al., 2019; Nita et al., 2017; Rozak & Wardina, 2014). As expressed by Ki Hajar Dewantara, Tri-N is not a thinking process but rather the stages of learning that children will carry out (Herawati, 2019; Rozak & Wardina, 2014). Tri-N consists of 3 stages: *Niteni*, *Nirokke*, and *Nambahi*. *Niteni*, taken from the Javanese language *"titen"*, is a student activity carried out by paying attention, comparing, observing, being observant and in-depth, involving the five senses carefully, recognizing and capturing the meaning of an object (Damayanti & Rochmiyati, 2019; Istiqomah et al., 2021; Nisa et al., 2019; Novika & Harahap, 2018). So that students can obtain specific and in-depth information that is linked to students' prior knowledge. Students are expected to carry out the Niteni stage after carrying out the *Nirokke* stage. This second stage is the student's behaviour, which is to imitate the example given by the teacher or other learning sources (Rochmiyati & Putro, 2020; Wijayanti et al., 2021). *Nirokke* is very useful for students because it has the nature of self-education through orientation and experience (Sibyan et al., 2019; Wijayanti & Utaminingsih, 2017). Apart from that, the *Nirokke* stage is helpful for students to absorb the information provided by the teacher. The final stage of Tri-N is *Nambahi.* It is hoped that students will not only imitate or duplicate information received by the teachers expected to process the information they obtain (Herawati, 2019; Rozak & Wardina, 2014). They have creative and innovative abilities to give new colours to models or other imitated learning resources. The Tri-N stages in the worksheet cause students' critical thinking skills to be better when compared to using ordinary worksheets.

Implication of Research

In the prototype developed in this research in the form of a Tri-N based relations and function worksheet using the first three stages of 4D development research, it was found that the prototype worksheet was theoretical and empirical. Several implications are obtained based on this research, including that learning using Tri-N based worksheets on Relations and Function material can improve students' critical thinking skills on mathematics problems for junior high school students. This can be seen from the results of the N-Gain test and the effect size. For this reason, teachers in mathematics learning relationship and function material can consider using this research product to improve students' critical thinking skills.

Limitation

This research generally uses 4D development stages: define, design, develop and disseminate. The number of validators involved in assessing the product of Worksheet Tri-N is only six people, namely 3 (three) junior high school mathematics teachers and 3 (three) lecturers with a scientific background in mathematics education. However, there are no validators from lecturers who know mathematics learning technology. This is one of the weaknesses of this research.

Apart from that, at the product testing stage, an experiment was carried out to determine the effect of the development product (in this case, a Worksheet based Tri-N) on students' critical thinking skills on relationship and function material. However, the experiments did not compare the effects of worksheet based Tri-N and other worksheet models. For this reason, the results of this research can be considered to compare the effects of using worksheet based Tri-N with other worksheet models on students' critical thinking skills.

CONCLUSION

Based on the results of research and discussion, it can be concluded that mathematical worksheet based Tri-N in material relation and function Improving the critical thinking skills of junior high school students has been successfully developed. Relation and function worksheet based Tri-N has theoretically and empirically fulfilled the feasibility test. Empirically, this worksheet obtained a Vaiken index of more than 0.78 for each assessment sub-indicator, so it can be declared valid. The results of students' responses to relation and function worksheet based Tri-N to improve the critical thinking skills of junior high school students obtained the result that 62.28% of students gave a very agree response and 37.79% of students gave a very agree response. From the students' responses, it can be concluded that relation and function worksheet-based Tri-N obtained positive responses (practical) from students to improve their critical thinking skills. Apart from the test results at the dissemination stage, it was found that the N-gain results were 0.53, and the effect size was 1.37. These results indicate that the Relation and Function worksheet based on Tri-N is effective for use in mathematics learning regarding students' critical thinking abilities.

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