European Journal of Educational Research
Volume 10, Issue 1, 497 - 508.
ISSN: 2165-8714
https://www.eu-jer.com/

The Implementation of Mathematics Comic through Contextual Teaching and Learning to Improve Critical Thinking Ability and Character

Farida Puput Lestari*
Universitas Negeri Semarang, INDONESIA

Farid Ahmadi
Universitas Negeri Semarang, INDONESIA

Rochmad Rochmad
Universitas Negeri Semarang, INDONESIA

Received: September 4, 2020 ▪ Revised: December 8, 2020 ▪ Accepted: January 15, 2021

Abstract: Students' critical thinking ability requires improvement from schools as an educational institution. Besides, it is important to maximally integrate character education into mathematics learning. One of the attempts was implementing mathematics comic that contains Pancasila values as teaching material through contextual teaching and learning. Therefore, this study aims to analyze the effectiveness of mathematics comic teaching material with Pancasila values in improving students' critical thinking and character. This is a quasi-experimental study that involves non-equivalent control group design. The population was fourth-grade students of elementary schools in Gajahmungkur District, and data were collected using a critical thinking test and questionnaire. The results showed that using mathematics comic teaching material with Pancasila values was (1) effective in improving students' critical thinking ability; (2) effective in developing character, especially discipline and hard work trait. In the beginning, both character traits were categorized as good, and after treatment, there was an increase in the very good category. Therefore, it can be concluded that the use of mathematics comic teaching material with Pancasila values is effective in improving critical thinking ability and character traits.

Keywords: *Mathematics comic; critical thinking; character education; contextual teaching and learning.*

To cite this article: Lestari, F. P., Ahmadi, F., & Rochmad, R. (2021). The implementation of mathematics comic through contextual teaching and learning to improve critical thinking ability and character. *European Journal of Educational Research, 10*(1), 497-508. https://doi.org/10.12973/eu-jer.10.1.497

Introduction

The world is becoming more advanced, therefore human capability also needs to be upgraded. In the Industry 4.0 revolution, students need to possess several skills in order to survive. These skills include critical thinking, problem-solving, communication (Salimi et al., 2021), collaboration, creativity and innovation (Anagün, 2018; Trilling & Fadel, 2009), as well as internet literacy (Ahmadi et al., 2020; Ahmadi & Maharani, 2019). Critical thinking is an activity stimulated by a particular reason and is aimed at making a decision (Ennis, 1993), interpreting, predicting, analyzing, and evaluation (Abrami et al., 2015). Furthermore, it evaluates whether an individual should be confident that some arguments are sound (Epstein & Kernberger, 2006). Also, critical thinking ability involves several activities such as implementing information on a new situation, analyzing the cause of a phenomenon, and evaluating an opinion (Aizikovitsh-Udi & Cheng, 2015).

This ability comprises a collection of sub-skills such as analysis (Ratnasari et al., 2018), evaluation, and inference to determine a logical and the best possible solution to a problem or a valid conclusion (Dwyer et al., 2011). Therefore, critical thinking requires cognitive activity by considering logical and objective aspects to draw a reliable conclusion (Saputri et al., 2020). Furthermore, people who think critically can formulate and communicate good arguments and make better decisions (Epstein, 2016).

Critical and creative thinking are essential for students (Abrami et al., 2015; Dekker, 2020; Toheri et al., 2020) to help them solve complex problems in their lives (Kardoyo et al., 2020; Yayuk et al., 2020). It was reported that those with critical thinking ability can effectively and systematically solve problems (Chukwuyenum, 2013; Peter, 2012). Therefore, students need to have both abilities to solve problems, either during learning or daily activity.

Critical thinking can be developed through guidance at all educational levels and disciplinary areas using several effective strategies (Abrami et al., 2015). One of the subjects that can be used in school is Mathematics, which plays an

* **Corresponding author:**
Farida Puput Lestari, Jl. Kelud Utara III, Semarang, Central Java, 50237, Indonesia. ✉ faridapuputl@gmail.com

essential role developing students critical thinking (As'ari et al., 2017; Yayuk et al., 2020). It would be best to maximize mathematics delivery, especially in elementary school to develop this ability (Kurniati et al., 2015; Munawaroh et al., 2018). Therefore, schools should be able to develop critical thinking ability through Mathematics learning.

However, current mathematics teaching and learning is still unable to encourage students to think critically. Hence, it is not surprising that critical thinking ability is relatively low. Based on results, the fifth-grade students in Pasar Kliwon sub-district have a low critical thinking ability in mathematics (Munawaroh et al., 2018). Meanwhile, previous literature stated that the issue is caused by the teaching and learning process that tends to be teacher-centred, thereby hindering students from actively participating in the learning process (Mulyanto et al., 2018; Widyatiningtyas et al., 2015). This situation also happens in Western cultures, in which the teacher tends to solely demonstrate and discuss the material in classrooms (Boyd & Ash, 2018). In addition, mathematics learning evaluation only focuses more on regular exercises and low-level questions. Hence, students were only exposed to low order thinking skills (Kurniati et al., 2015).

Authors identified this lack of critical thinking ability during observation in a public elementary school (SDN), Sampangan 02 in Semarang. Out of the 35 students who were given critical thinking exercises, only 21% answered correctly, while the remaining failed. According to the observation and interview with teachers and students in the school, it was shown that this ability is not well developed, and teachers act as the primary focus during the learning process. Consequently, students became passive in learning and used to learn by memorizing. In addition, non-routine problems that can develop critical thinking are rarely given.

Another problem is the limited availability of teaching resources that contain character building. The available teaching resources are old books that do not contain any character education. Therefore, the integration between character education and mathematics learning is not yet optimal. Besides critical and creative thinking, character education is vital in education as many issues are frequently caused by decreased students' character (Agboola & Tsai, 2012; Pertiwi et al., 2019). Hence, provision of character education as early as possible can help solve the most basic educational issues since many types of juvenile delinquencies like violence, brawl, and bullying have increased recently (Saputro & Soeharto, 2015).

Education in elementary schools needs to be enhanced, in order to build a more robust character. A good and strong character is essential for an individual because it affects their behaviour and social life (Septiani et al., 2020). However, it can never be achieved when the learning process only emphasizes the cognitive aspect (Saputro & Soeharto, 2015; Septiani et al., 2020).

Building a good character is a collective work among parents, school, and community. It is expected that children's negative behaviour during school or within the family and community can be minimized (Agboola & Tsai, 2012; Hermino & Arifin, 2020). Therefore, the school plays an integral role in developing character (Çubukçu, 2012). Also, it is necessary for a school as an educational institution to develop learning that facilitates character development.

Action should be taken to improve critical thinking ability and develop the character of students. One of the attempts that can be carried out is to create an exciting teaching material adjusted to students' characteristics. It should also include non-routine problems to develop critical thinking ability and Pancasila values to build character.

Values that should be taught to make students good and smart citizen based on the five principles of Pancasila are religiosity, humanity, unity, democracy, and justice (Octavia & Rube'i, 2017). Meanwhile, the values in every principle represent the character of the country, hence they should be taught (Damanhuri et al., 2016). Pancasila is the basis for the Indonesian nation's character, described as great, modern, dignified, and cultured (Amir, 2013). Therefore, it is crucial to inculcate elementary school students with the Pancasila values.

Some factors can facilitate better learning, one of which is proper teaching materials (Wuryani et al., 2018). These materials play a key role in a teaching and learning process at school. Therefore, it should be arranged in advance to support learning activity and encourage students to be more active (Nalurita et al., 2010). There are various types of teaching materials, and comic is one of them.

The comic material has several advantages such as stimulating interest in reading and motivation to learn, especially for elementary school students as it contains many pictures that are suitable with their level of development (Daulay, 2017; Ntobuo et al., 2018). Comics that consist of simple and straightforward illustrations may be better than other learning tools (Kim et al., 2016). Furthermore, they are liked by many people from various backgrounds and ages (Özdemir, 2017), thereby making it suitable to be applied as a teaching material to support learning activities.

The use of comic is favourable to develop students' character. Besides being applied in real life, such as at school and home, character development can also be made as an illustration in textbooks (Patria & Mutmainah, 2018). Character education can be delivered through teaching and learning using character-based comic (Murti et al., 2020). Previous studies on comics for mathematics learning in elementary school showed that it improved character and achievement (Buchori & Setyawati, 2015). Comics can also improve learning motivation, and are liked by children, which gives them confidence and motivation (Hosler & Boomer, 2011; Norton, 2003).

Mathematics is a science discipline about abstract structures (Jankvist, 2015; Yadav, 2017). However, the cognitive development of students is still on the concrete operational stage where they can solve problems that are related to concrete action or events (Ghazi & Ullah, 2015; Ojose, 2008). Therefore, it is suggested that linking mathematics to students' world and contextual teaching and learning can be a solution.

Contextual teaching and learning (CTL) is an approach that requires a teacher to present real-life situation in class, in order to encourage students to connect the knowledge they have and apply it contextually (Davtyan, 2014; Yudha et al., 2019). Making connections between real life and mathematics is essential to be emphasized in learning, in order to make student understand the value in daily life (Alangui, 2017; Coskun et al., 2020). Meanwhile, contextual teaching and learning involve students actively figuring out knowledge based on their experience, making the learning process more meaningful (Selvianiresa & Prabawanto, 2017; Toheri et al., 2020).

Previous studies confirmed that contextual teaching and learning (CTL) effectively encouraged learning motivation and achievement (Laili, 2016). Also, the CTL help students to develop their critical thinking ability (Tari & Rosana, 2019). In this teaching and learning, students are guided to construct knowledge based on their experience and develop meaningful concepts, since constructivist learning is important and beneficial to their critical thinking ability (Kwan & Wong, 2014).

Combining mathematics comic, which contains Pancasila values as material and contextual teaching and learning, it is expected that it will develop critical thinking ability and build better character. Presumably, this finding may serve as an alternative for any similar issues regarding the development of character and critical thinking ability, as well as lack of mathematics teaching materials that contain character education. Therefore, this study aims to improve students' ability and build their character by using mathematics comic containing Pancasila values as teaching material.

Methodology

Research Objectives and Design

This is a quantitative study with a quasi-experimental design that analyzes the effectiveness of mathematics comic teaching material that contains Pancasila values in CTL. These are for improving students' critical thinking and character. The subjects consist of two groups, namely experimental and control class. In the experimental class, teaching material in the form of comic was given as treatment. On the other hand, the control group was given contextual teaching and learning without Pancasila values.

The comic tells about the daily life of an elementary school student who has difficulties in learning mathematics. Also, related topics are integrated into the comic story, which is made colourful, and the characters are drawn as a cartoon that has a body shape resembling flat figures (square, rectangle, triangle, ellipse, and circle). An example can be seen in Figure 1.

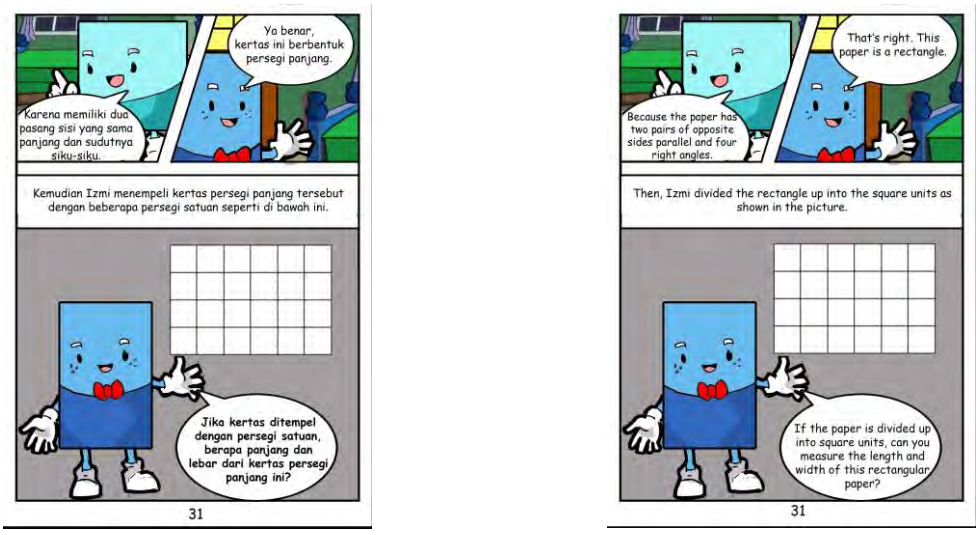

Figure 1. An example of the comic used in Bahasa Indonesia and English

Sample and Data Collection

The subjects were 243 grade IV students in Gajahmungkur District, Semarang City. They were from four schools, namely Sampangan 01 and 02, Bendan Ngisor, and Gajahmungkur 02. Cluster random sampling was used to determine the study sample. Furthermore, the population was divided into one experimental, one control, and one instrument trial class. The first stage of the cluster random sampling technique was conducting a statistical testing of the four

schools. The used statistical tests were the normality, homogeneity, and the average similarity test using the latest results.

The samples were randomly determined from four schools which were declared normal, homogeneous, and had the same average. Based on the random selection results, two classes were selected as the experiment and control, consisting of class IV A (23 students) and IV B (25 students) at Sampangan 02 elementary school. The research team as chose one class, IV B Bendan Ngisor as the instrument testing class.

Test and non-test means (questionnaires) were used as data collection techniques. The Watson-Glaser's Critical Thinking Appraisal instrument (Watson & Glaser, 2002) was used to test the critical thinking ability with the following indicators: (1) inference; (2) recognition of assumptions; (3) deduction; (4) interpretation; and (5) evaluation of arguments. Meanwhile, the critical thinking ability test was in the form of an essay adjusted to the characteristics of the fourth-grade students.

The other instrument was the questionnaire of discipline and hard work character traits using the Guttman scale with "yes" and "no" as the options. The indicators of discipline character trait are as follows: (1) enter into the class on time; (2) maintain classroom order; (3) remind those who break the rules with polite and non-offensive words; (4) complete assignments on time; (5) dress neatly and politely; (7) comply with the rules formulated by teacher in the classroom. Meanwhile, the indicators of hard work character trait are as follows: (1) carefully and neatly execute the task; (2) finish the assignments from the teacher on time; (3) seek information about lessons from various sources; (4) do all classwork seriously; (5) take notes seriously about what is read, observed, and heard in class (Hasan et al., 2010).

The instruments used were validated by experts consisting of two lecturers and two teachers. Subsequently, revisions were made according to experts' advice. After the instruments were declared valid, they were tested on 38 fourth grade students of Bendan Ngisor elementary school as a test class. The test instrument validity in the form of essay was measured using Pearson's Product Moment formula. Seven out of twelve questions tested were declared valid because r_{xy} was higher than r_{table}. Furthermore, the instrument's reliability was measured using Cronbach's Alpha formula and was declared reliable with the reliability coefficient of 0.89. For the questionnaire, the reliability was measured using the K-R 20 formula and declared reliable with a reliability coefficient of 0.72.

Instruments were given to students in the experiment and control class. The data collection was conducted twice, before and after the learning process. In addition, the pretest and posttest that were given have the same form and difficulty level.

Data Analysis

There were several steps of data analysis using SPSS. The initial analysis was conducted to determine whether the samples used have identical initial conditions. The normality, homogeneity, and test of the preliminary data balance from the experimental and control class were conducted to the initial. In this study, the Kolmogorov-Smirnov test was used to check the normality assumption, while Levene's test was used as the homogeneity test of variance.

Before testing the hypothesis, it was necessary to conduct normality, homogeneity, and t-test for the pretest data. The normality test aims to determine whether the data obtained were normally distributed while the homogeneity test aims to determine whether the sample data have a similarity variance (homogeneous). The results from the normality test can be seen in Table 1.

Table 1. Normality Test Results on Students' Critical Thinking Ability

Class		Kolmogorov-Smirnov[a]		
	Data	Statistic	df	*p*
Experiment	Pretest	0.75	46	0.63
	Posttest	0.78	46	0.58
Control	Pretest	0.55	46	0.92
	Posttest	0.83	46	0.50

Table 1 shows that both classes' p-value of the pretest and post-test data is higher than 0.05, which means that the results of the experiment and control class are normally distributed. The results of the homogeneity of variance test can be seen in Table 2.

Table 2. Homogeneity Test Results on Students' Critical Thinking Ability

	Student Learning Outcomes			
	F	df_1	df_2	*p*
Pretest	0.12	1	46	0.74
Posttest	1.21	1	46	0.28

Table 2 shows that the p-value of pretest and post-test scores of both classes is higher than 0.05. Therefore, it can be concluded that the results of the experiment and control class are homogeneous.

Before using inferential statistics, normality and homogeneity tests on the posttest results were carried out. After the data passed the prerequisite test, it was analyzed using parametric statistics. Also, the significance level used was $\propto = 0.05$. The two-tailed independent t-test and the N-Gain analysis were the statistical tests used to measure the effectiveness of teaching material in mathematics comics to improve students' critical thinking. The formula below was used to obtain the N-Gain score value (Hake, 1999).

$$N - gain = \frac{Posttest\ Score - Pretest\ Score}{100 - Pretest\ Score}$$

Subsequently, the *N-Gain* score was categorized using Meltzer category (Meltzer, 2002), which can be seen in Table 3.

Table 3. N-Gain Score Value Category

N-Gain Score Value	Category
$\mathrm{N-Gain} \geq 0.70$	High
$0.30 < N - Gain < 0.70$	Medium
$\mathrm{N-Gain} \leq 0.30$	Low

As shown in Table 4, the pretest and posttest scores on critical thinking ability are calculated and categorized into the following (Setyowati et al., 2011).

Table 4. Categories for Critical Thinking Ability

Categories	Interval
Very High	81.25 < Score ≤ 100
High	71.5 < Score ≤ 81.25
Moderate	62.5 < Score ≤ 71.5
Low	43.75 < Score ≤ 62.5
Very Low	0 < Score ≤ 43.75

Schools have passing grade criteria to indicate that students have mastered the material. However, in this study, the criteria for passing was based on the actual passing grade (APG). APG is based on the actual or average score of the students, and the APG score for critical thinking ability in this study was 65. This was based on the score achieved on the initial test which was conducted using the formula $\bar{x} + 0.25s$.

Furthermore, the character trait questionnaire of discipline and hard work were calculated and interpreted into the following categories, as shown in Table 5.

Table 5. Character Assessment Rubric

Interval Scores	Categories
Mi + 1.5SDi ≤ X ≤ Mi + 3SDi	Very good
Mi + 0SDi ≤ X ≤ Mi + 1.5SDi	Good
Mi − 1.5SDi ≤ X ≤ Mi + 0SDi	Fairly good
Mi − 3SDi ≤ X ≤ Mi − 1.5SDi	Poor

X = score obtained

Mi = average $= \frac{1}{2} \times$ (maximum score + minimum score)

SDi = standard deviation $= \frac{1}{6} \times$ (maximum score − minimum score)

Findings / Results

The results were obtained from several tests. From the tests, data about critical thinking ability and character were obtained. The test results can be seen in Table 6.

Table 6. Description of the Score of Students' Critical Thinking Ability

Class		Range	Min.	Max	Mean	S	S^2
Pretest	Experiment	60	31	91	59.26	15.37	236.11
	Control	71	20	91	51.88	16.64	276.94

Posttest	Experiment	57	43	100	79.65	14.28	203.87
	Control	63	31	94	68.28	16.20	262.54

It can be seen from the preliminary data of pretest in Table 6, that the critical thinking ability in the experimental and control class is low. The average value of both classes is below 62.5, and it does not pass the APG. Meanwhile, the post-test results showed that average critical thinking ability in the experiment class is 79.65 and categorized as high. Simultaneously, the average thinking ability of students in the control class is 68.28 and considered moderate. From the posttest results, it can be concluded that the average value of the experiment and control class increased and passed the APG criteria.

The classification and number of students based on critical thinking ability level from the posttest scores of the experimental and control class are presented in Table 7.

Table 7. Number of Posttest Students in Each Category of Critical Thinking Ability

Category	Interval	Experiment Class	Control Class
Very High	81.25 < Score ≤ 100	12 students	1 student
High	71.5 < Score ≤ 81.25	6 students	3 students
Moderate	62.5 < Score ≤ 71.5	3 students	3 students
Low	43.75 < Score ≤ 62.5	1 student	11 students
Very Low	0 < Score ≤ 43.75	1 student	7 students

Table 7 shows that most of the experimental class students have a very high critical thinking ability, while in the control, most students are in the low category. The results showed that the pretest sample data are normally distributed and homogeneous. The next step was conducting the balance test for the pretest data using a two-tailed independent t-test. The results can be seen in Table 8.

Table 8. Results of the Average Similarity Test of Students' Critical Thinking Ability (Pretest) Independent Samples Test

Levene's Test for Equality of Variances		t-test for Equality of Means								
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Pretest	Equal variances assumed	.12	.73	1.59	46	.12	7.38	4.64	-1.95	16.71
	Equal variances not assumed			1.59	45.99	.12	7.38	4.62	-1.92	16.68

The results of the calculation from Table 8 showed that there were no significant differences in pretest score between the experimental and control class (t [46] = 1.59; $p > 0.05$). This showed that both groups have equal initial skills.

After conducting the required tests, three teaching treatments were given to the experimental and control class. The teaching materials consisted of circumference and surface area of a square, rectangle, and triangle. In the experiment class, the mathematics comic was used as teaching material, while in the control class, contextual teaching and learning was used without Pancasila values.

The normality and homogeneity analysis of posttest results are necessary for testing the hypothesis. The post-test results of the experimental and control class showed a normal and homogeneous score. The next step was to analyze the effectiveness of mathematics comic as teaching material in improving critical thinking ability. Firstly, the two-tailed independent t-test was conducted, and the results can be seen in Table 9.

Table 9. Results of the Independent Sample t-test of Students' Critical Thinking Ability Independent Samples Test

Levene's Test for Equality of Variances		t-test for Equality of Means								
									95% Confidence Interval of the Difference	
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
Posttest	Equal variances assumed	1.21	.28	2.57	46	.013	11.37	4.42	2.47	20.28
	Equal variances not assumed			2.58	45.92	.013	11.37	4.40	2.51	20.23

As seen from Table 9, the difference of the posttest scores between the experimental and control class is (t [46] = 2.57; p < 0.05). Meanwhile, the average score of the critical thinking ability test between the experimental class is different from the control.

Secondly, after the two-tailed independent t-test showed a significant difference between the experimental and control classes, the N-gain test was carried out. The results can be seen in Table 10.

Table 10. Results of the N-Gain Test for Students' Critical Thinking Ability

Class	N	Pretest	Posttest	N-Gain	Category
Experiment	23	59.26	79.65	0.50	Medium
Control	25	51.88	68.28	0.34	Medium

From the pretest and posttest results presented in Table 10, it can be seen that the scores increase, and are classified into the medium category. In the experiment class, the increase is higher than the control, as indicated by the high N-Gain score. In other words, the use of mathematics comics through contextual teaching and learning effectively improved critical thinking ability in the experiment class.

In addition, this study observed students character traits of discipline and hard work. The data collected from the questionnaire can be seen in Table 11 and Table 12.

Table 11. Results of Students' Discipline Character Trait Questionnaire

Class	Initial	Category	Final	Category	N-Gain	Category
Experiment	10.87	Good	14.78	Very Good	0.76	High
Control	10.40	Good	12	Good	0.29	Low

From Table 11, it can be seen that the discipline character trait in the experimental and control class showed an improvement, but with a more excellent score in the experiment class, from the category of "good" to "very good". Also in Table 12, it can be seen that the character trait of hard work in the experiment and control class showed an improvement with a greater score in the experiment class, from the category of "good" to "very good". Therefore, using this material through contextual teaching and learning is effective to improve character traits of discipline and hard work.

Table 12. Results of Students' Hard Work Character Trait Questionnaire

Class	Initial	Category	Final	Category	N-Gain	Category
Experiment	8.35	Good	12.52	Very Good	0.74	High
Control	8.80	Good	9.84	Good	0.20	Low

Discussion

The difference of average score between the experimental and control class showed that using mathematics comics as teaching material effectively improved critical thinking ability. This is in accordance with Krusemark, which suggested that comic use has the same or even more significant influence than regular textbook (Krusemark, 2016).

The mathematics comic used as teaching material in the experiment class effectively improved critical thinking. Therefore, students in the experimental class are better than the control.

This result is in line with studies that comic books can teach and develop students' ability (Ariesta & Purwanti, 2019; Rapp, 2011), interest in learning mathematics, and developing 21st-century skills (Toh et al., 2017; Trimurtini et al., 2020). Furthermore, it was found that comic is suitable for students because it stimulates them to study harder, improve their performance, and attract the comic visual (Hosler & Boomer, 2011; Wijayanti et al., 2018). Hence, it gives a positive influence on students' achievement. In addition to improving achievement, comics can positively impact learning outcomes because they helps students learn effectively (Azamain et al., 2020; Puspitorini et al., 2014). Therefore, it can be used in the classroom to engage students in critical thinking (Krusemark, 2015). Comic requires readers to think critically (McCloud, 1993; Rapp, 2011) and increase inference ability because they are presented in a sequential verbal and visual form.

The combination of pictures and texts in comics can increase understanding of the material (Hosler & Boomer, 2011; Saputro & Soeharto, 2015). In fact, they can make students more comfortable to learn with a concrete mindset and facilitate cognitive development (Azamain et al., 2020; Pardimin & Widodo, 2017).

There is a discussion process in contextual teaching and learning that improves critical thinking ability (Abrami et al., 2015; Dekker, 2020), especially when the teacher poses questions during class discussion. This result is supported by

previous studies, and learning environments that facilitate social interactions are essential for developing critical thinking (Kwan & Wong, 2014). Besides, contextual teaching and learning can also improve thinking ability through problems in daily lives (Toheri et al., 2020). Based on the results, it was found that when a teacher links mathematical problem to a real-life situation, students tend to think critically (Aizikovitsh-Udi & Cheng, 2015). Furthermore, the use of non-routine problems can increase critical thinking ability (Widana et al., 2018).

Based on the analysis results, the character trait development of discipline and hard work in the experimental class is better than the control. This showed that the use of mathematics comic containing Pancasila values successfully improved character trait. Meanwhile, values delivered through the characters' behaviour in the comic greatly influence students. This result confirmed previous studies, which found that comics improved learning motivation and character (Buchori & Setyawati, 2015; Rina et al., 2020; Widyawati & Prodjosantoso, 2015). In the learning process, comic plays a role in positively shaping students' attitudes (Hosler & Boomer, 2011).

A learning process that prioritizes the internalization of local wisdom values and implementation in daily life focuses on current character education activities (Hermino & Arifin, 2020; Murti et al., 2020). Meanwhile, Pancasila contains values that guide the life of the Indonesian people and the nation. One of these values is being disciplined and working hard in learning and everyday life. Therefore, students who are disciplined and work hard in learning will better solve mathematical problems. This can be seen from this study, which showed that those with high level of discipline and hard work also have high critical thinking ability.

Conclusion

This study aims to improve critical thinking ability and character trait of elementary school students by utilizing a Pancasila value-based math comic. Based on the results, it can be concluded that integrating comics that contain Pancasila values is effective in improving the critical thinking ability of fourth-grade students. Meanwhile, the mathematics comic has suitable characteristics because it is attractive and stimulates students to study harder, and positively influence their achievement. Furthermore, the use of non-routine and contextual problems may increase students' critical thinking ability. In addition, they showed an increase of discipline and hard work after being taught with mathematics comic that contains Pancasila values.

Recommendations

Based on the results, there are several recommendations: (1) Teachers should integrate comics to improve critical thinking ability; (2) Teachers can re-emphasize examples of good behaviour, hence, integration of character education can be maximized; and (3) the use of a contextual problem can facilitate students in understanding material. Nevertheless, further study on materials and character education in a more extended period is needed.

Limitations

Some limitations in this study include analyzing the students' character traits which cannot be deeply conducted by observing their daily lives during learning. Additionally, the teaching and learning process using mathematics comics containing Pancasila values was not implemented for a long time (only during the study period). Lastly, the character traits used only two out of 18 that the Indonesian students need to posses.

References

Abrami, P. C., Bernard, R. M., Borokhovski, E., Waddington, D. I., Wade, C. A., & Persson, T. (2015). Strategies for teaching students to think critically: A meta-analysis. *Review of Educational Research*, *85*(2), 275–314. https://doi.org/10.3102/0034654314551063

Agboola, A., & Tsai, K. C. (2012). Bring character education into classroom. *European Journal of Educational Research*, *1*(2), 163–170. https://doi.org/10.12973/eu-jer.1.2.163

Ahmadi, F., Edi, S., Al-ghamdi, B. A. A., & Harjunowibowo, D. (2020). Comparative study of the development of android-based flipped classroom model between Jeddah and Indonesia. *International Journal on Advanced Science Engineering Information Technology*, *10*(2), 542–547.

Ahmadi, F., & Maharani, S. P. (2019). E-learning based on "Joomla!" to improve the learning results of social studies content in primary school. *International Journal of Innovation, Creativity and Change*, *5*(5), 394–405.

Aizikovitsh-Udi, E., & Cheng, D. (2015). Developing critical thinking skills from dispositions to abilities: Mathematics education from early childhood to high school. *Creative Education*, *6*(4), 455–462. https://doi.org/10.4236/ce.2015.64045

Alangui, W. V. (2017). Ethnomathematics and culturally relevant mathematics education in the Philippines. In M. Rosa, L. Shirley, M. E. Gavarrete & W. V. Alangui (Eds.), *Ethnomathematics and its Diverse Approaches for Mathematics Education* (pp. 183–208). Springer, Cham. https://doi.org/10.1007/978-3-319-59220-6_8

Amir, S. (2013). Pancasila as integration philosophy of education and national character. *International Journal of Scientific and Technology Research*, *2*(1), 54–57.

Anagün, Ş. S. (2018). Teachers' perceptions about the relationship between 21st century skills and managing constructivist learning environments. *International Journal of Instruction*, *11*(4), 825–840. https://doi.org/10.12973/iji.2018.11452a

Ariesta, F., & Purwanti, E. (2019). Build critical thinking skills of elementary school students through comics social science based-problem. In A. Subagyo, J. Abraham, T. N. Mursitama, R. Rahim, & M. T. Multazam (Eds.), *The 1st Workshop on Multimedia Education, Learning, Assessment and its Implementation in Game and Gamification in conjunction with COMDEV 2018*. European Alliance for Innovation (EAI). https://doi.org/10.4108/eai.26-1-2019.2282933

As'ari, A. R., Mahmudi, A., & Nuerlaelah, E. (2017). Our prospective mathematic teachers are not critical thinkers yet. *Journal on Mathematics Education*, *8*(2), 145–156. https://doi.org/10.22342/jme.8.2.3961.145-156

Azamain, M. S., Shahrill, M., Musa, N. K. H., & Batrisyia, I. (2020). How using comics can assist in determining the students' learning of distance-time graphs. *Journal of Physics: Conference Series*, *1470*(1), 1-9. https://doi.org/10.1088/1742-6596/1470/1/012005

Boyd, P., & Ash, A. (2018). Mastery mathematics: Changing teacher beliefs around in-class grouping and mindset. *Teaching and Teacher Education*, *75*, 214–223. https://doi.org/10.1016/j.tate.2018.06.016

Buchori, A., & Setyawati, R. D. (2015). Development learning model of character education through e-comic in elementary school. *International Journal of Education and Research*, *3*(9), 369–386.

Chukwuyenum, A. N. (2013). Impact of critical thinking on performance in mathematic. *IOSR Journal of Research & Method in Education*, *3*(5), 18–25.

Coskun, S. D., Bostan, M. I., & Rowland, T. (2020). An in-service primary teacher's responses to unexpected moments in the mathematics classroom. *International Journal of Science and Mathematics Education*, *19*, 193–213. https://doi.org/10.1007/s10763-020-10050-4

Çubukçu, Z. (2012). The effect of hidden curriculum on character education process of primary school students. *Educational Sciences: Theory and Practice*, *12*(2), 1526–1534.

Damanhuri, D., Legiani, W. H., Bahrudin, F. A., & Rahman, I. N. (2016). Implementasi nilai-nilai Pancasila sebagai upaya pembangunan karakter bangsa [Implementation of Pancasila values as an effort to develop national character]. *Untirta Civic Education Journal*, *1*(2), 185–198. https://doi.org/10.30870/ucej.v1i2.1890

Daulay, M. I. (2017). Developing social science-history's comics- based learning media for the fifth grade of primary school in Pekanbaru City. *International Journal of Research in Counseling and Education*, *1*(1), 15–21. https://doi.org/10.24036/008za0002

Davtyan, R. (2014, April 3-4). *Contextual learning* [Paper presentation]. American Society for Engineering Education 2014 Zone I Conference, University of Bridgeport, Bridgeport, CT, USA.

Dekker, T. J. (2020). Teaching critical thinking through engagement with multiplicity. *Thinking Skills and Creativity*, *37*, 1–9. https://doi.org/10.1016/j.tsc.2020.100701

Dwyer, C., Stewart, I., & Hogan, M. J. (2011). The promotion of critical thinking skills through argument mapping. In C. P. Horvath & J. M. Forte (Eds.), *Critical Thinking* (pp. 97–122). Nova Science Publishers.

Ennis, R. H. (1993). Critical thinking assessment. *Theory Into Practice*, *32*(3), 179–186. https://doi.org/10.1080/00405849309543594

Epstein, R. L. (2016). *The pocket guide to critical thinking* (5th ed.). Advanced Reasoning Forum.

Epstein, R. L., & Kernberger, C. (2006). *Critical thinking* (3th ed.). Thomson Wadsworth.

Ghazi, S. R., & Ullah, K. (2015). Formal operational stage of Piaget's cognitive development theory: An implication in learning mathematics. *Gomal University Journal of Research*, *31*(1), 79–89.

Hake, R. R. (1999, March 13). *Analyzing change/gain scores*. Indiana University. https://cutt.ly/QjEMOWn

Hasan, S. H., Wahab, A. A., Mulyana, Y., Hamka, Kurniawan, Anas, Z., Nurlaili, L., Listiyanti, M., Jarwadi, Chatarina, M., Waluyo, H., Wirantho, S. A., Paresti, S., & Ismail, A. B. (2010). *Penguatan metodologi pembelajaran berdasarkan nilai-nilai budaya untuk membentuk daya saing dan karakter bangsa [Strengthening learning methodology based on cultural values to form competitiveness and national character]*. Ministry of National Education/ Kementerian Pendidikan Nasional.

Hermino, A., & Arifin, I. (2020). Contextual character education for students in the senior high school. *European Journal*

of Educational Research, *9*(3), 1009–1023. https://doi.org/10.12973/EU-JER.9.3.1009

Hosler, J., & Boomer, K. B. (2011). Are comic books an effectiveway to engage nonmajors in learning and appreciating science? *CBE Life Sciences Education*, *10*(3), 309–317. https://doi.org/10.1187/cbe.10-07-0090

Jankvist, U. T. (2015). Changing students' images of "mathematics as a discipline". *Journal of Mathematical Behavior*, *38*, 41–56. https://doi.org/10.1016/j.jmathb.2015.02.002

Kardoyo, Nurkhin, A., Muhsin, & Pramusinto, H. (2020). Problem-based learning strategy: Its impact on students' critical and creative thinking skills. *European Journal of Educational Research*, *9*(3), 1141–1150. https://doi.org/10.12973/EU-JER.9.3.1141

Kim, J., Chung, M. S., Jang, H. G., & Chung, B. S. (2016). The use of educational comics in learning anatomy among multiple student groups. *Anatomical Sciences Education*, *10*(1), 79–86. https://doi.org/10.1002/ase.1619

Krusemark, R. E. (2015). The role of critical thinking in reader perceptions of leadership in comic books. *SANE Journal: Sequential Art Narrative in Education*, *2*(1), 1–25.

Krusemark, R. E. (2016). Comic books in the American college classroom: A study of student critical thinking. *Journal of Graphic Novels and Comics*, *8*(1), 1–19. https://doi.org/10.1080/21504857.2016.1233895

Kurniati, K., Kusumah, Y. S., Sabandar, J., & Herman, T. (2015). Mathematical critical thinking ability through contextual teaching and learning approach. *Indonesian Mathematical Society Journal on Mathematics Education*, *6*(1), 53–62.

Kwan, Y. W., & Wong, A. F. L. (2014). The constructivist classroom learning environment and its associations with critical thinking ability of secondary school students in Liberal Studies. *Learning Environments Research*, *17*(2), 191–207. https://doi.org/10.1007/s10984-014-9158-x

Laili, H. (2016). Keefektifan pembelajaran dengan pendekatan CTL dan PBL ditinjau dari motivasi dan prestasi belajar matematika [The effectiveness of the CTL and PBL approaches viewed from students' motivation and achievement in mathematics learning]. *Pytaghoras: Journal of Mathematics Education/ Pytaghoras: Jurnal Pendidikan Matematika*, *11*(1), 25–34. https://doi.org/10.21831/pg.v11i1.9679

McCloud, S. (1993). *Understanding comics: The invisible art*. HarperCollins.

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in diagnostic pretest scores. *American Journal of Physics*, *70*(12), 1259–1268. https://doi.org/10.1119/1.1514215

Mulyanto, H., Gunarhadi, G., & Indriayu, M. (2018). The effect of problem based learning model on student mathematics learning outcomes viewed from critical thinking skills. *International Journal of Educational Research Review*, *3*(2), 37–45. https://doi.org/10.24331/ijere.408454

Munawaroh, H., Sudiyanto, & Riyadi. (2018). Teachers' perceptions of innovative learning model toward critical thinking ability. *International Journal of Educational Methodology*, *4*(3), 153–160. https://doi.org/10.12973/ijem.4.3.153

Murti, D. K., Gunarhadi, G., & Winarno, W. (2020). Development of educational comic with local wisdom to foster morality of elementary school students: A need analysis. *International Journal of Educational Methodology*, *6*(2), 337–343. https://doi.org/10.12973/ijem.6.2.337

Nalurita, L., Siroj, R. A., & Putri, R. I. I. (2010). Bahan ajar kesebangunan dan simetri berbasis contextual teaching and learning (CTL) menggunakan macromedia flash [Teaching materials of similarity and symmetry based on contextual teaching and learning (CTL) using macromedia flash]. *Journal of Mathematics Education/ Jurnal Pendidikan Matematika*, *4*(1), 45–52.

Norton, B. (2003). The motivating power of comic books: Insights from Archie comic readers. *The Reading Teacher*, *57*(2), 140–147.

Ntobuo, N. E., Arbie, A., & Amali, L. N. (2018). The development of gravity comic learning media based on Gorontalo culture. *Indonesian Journal of Science Education/ Jurnal Pendidikan IPA Indonesia*, *7*(2), 246–251. https://doi.org/10.15294/jpii.v7i2.14344

Octavia, E., & Rube'i, M. A. (2017). Penguatan pendidikan karakter berbasis pancasila untuk membentuk mahasiswa prodi PPKN menjadi warga negara yang baik dan cerdas [The strengthening of character education based on Pancasila to form a student of PPKn major to be a good and intelligent citiz. *Social Horizon: Journal of Social Education/ Sosial Horison: Jurnal Pendidikan Sosial*, *4*(1), 111–124. https://doi.org/http://dx.doi.org/10.31571/sosial.v4i1.427

Ojose, B. (2008). Applying Piaget's theory of cognitive development to mathematics instruction. *The Matematics Educator*, *18*(1), 26–30.

Özdemir, E. (2017). Humor in elementary science: development and evaluation of comic strips about sound. *International Electronic Journal of Elementary Education*, *9*(4), 837–850.

Pardimin, & Widodo, S. A. (2017). Development comic based problem solving in geometry. *International Electronic Journal of Mathematics Education*, *12*(3), 233–241.

Patria, A. S., & Mutmainah, S. (2018). Using textbook illustration as media for developing character among primary students: Some research-based suggestion. *Journal of Education and Learning*, *12*(1), 52–56. https://doi.org/10.11591/edulearn.v12i1.6509

Pertiwi, R., Suchyadi, Y., Sumardi, & Rukmini. (2019). Implementasi program pendidikan karakter di sekolah dasar negeri Lawanggintung 01 Kota Bogor [Implementation of character education program in Lawanggintung 01 elementary school Bogor City]. *Journal of Elementary School Teacher Education and Teaching/ Jurnal Pendidikan & Pengajaran Guru Sekolah Dasar*, *2*(1), 41–46. https://doi.org/10.33751/jppguseda.v2i1.994

Peter, E. E. (2012). Critical thinking: Essence for teaching mathematics and mathematics problem solving skills. *African Journal of Mathematics and Computer Science Research*, *5*(3), 39–43. https://doi.org/10.5897/ajmcsr11.161

Puspitorini, R., Prodjosantoso, A. K., Subali, B., & Jumadi, J. (2014). Penggunaan media komik dalam pembelajaran IPA untuk meningkatkan motivasi dan hasil belajar kognitif dan afektif [The use of comic media in science instruction to improve motivation and cognitive and affective achievement]. *Journal of Educational Horizon/ Jurnal Cakrawala Pendidikan*, *3*(3), 413–420. https://doi.org/10.21831/cp.v3i3.2385

Rapp, D. N. (2011). Comic books' latest plot twist: Enhancing literacy instruction. *Phi Delta Kappan*, *93*(4), 64–67. https://doi.org/10.1177/003172171109300416

Ratnasari, D., Sukarmin, S., Suparmi, S., & Harjunowibowo, D. (2018). Analysis of science process skills of summative test items in physics of grade X in Surakarta. *Indonesian Journal of Science Education/ Jurnal Pendidikan IPA Indonesia*, *7*(1), 34-40. https://doi.org/10.15294/jpii.v7i1.10439

Rina, N., Suminar, J. R., Damayani, N. A., & Hafiar, H. (2020). Character education based on digital comic media. *International Journal of Interactive Mobile Technologies*, *14*(03), 107. https://doi.org/10.3991/ijim.v14i03.12111

Salimi, M., Dardiri, A., & Sujarwo. (2021). The profile of students' social skills of Bengawan Solo Elementary Nature School. *European Journal of Educational Research*, *10*(1), 211–226. https://doi.org/10.12973/eu-jer.10.1.211

Saputri, W., Corebima, A. D., Susilo, H., & Suwono, H. (2020). Qasee: A potential learning model to improve the critical thinking skills of pre-service teachers with different academic abilities. *European Journal of Educational Research*, *9*(2), 853–864. https://doi.org/10.12973/eu-jer.9.2.853

Saputro, B. H., & Soeharto, S. (2015). Pengembangan media komik berbasis pendidikan karakter pada pembelajaran tematik-integratif kelas IV SD [Developing character-based education comic media on integrate-thematic learning for fourth grade]. *Prima Educasia Journal/ Jurnal Prima Edukasia*, *3*(1), 61–72. https://doi.org/https://doi.org/10.21831/jpe.v3i1.4065

Selvianiresa, D., & Prabawanto, S. (2017). Contextual teaching and learning approach of mathematics in primary schools. *Journal of Physics: Conference Series*, *895*(1), 1–7. https://doi.org/10.1088/1742-6596/895/1/012171

Septiani, A. N. S. I., Rejekiningsih, T., Triyanto, & Rusnaini. (2020). Development of interactive multimedia learning courseware to strengthen students' character. *European Journal of Educational Research*, *9*(3), 1267–1279. https://doi.org/10.12973/eu-jer.9.3.1267

Setyowati, A., Subali, B., & Mosik. (2011). Implementasi pendekatan konflik kognitif dalam pembelajaran fisika untuk menumbuhkan kemampuan berpikir kritis siswa SMP [Implementation of conflict cognitive approach in physics learning to foster critical thinking skills of junior high school students]. *Indonesian Journal of Physics Education/ Jurnal Pendidikan Fisika Indonesia*, *7*(2), 89-96. https://doi.org/10.15294/jpfi.v7i2.1078

Tari, D. K., & Rosana, D. (2019). Contextual teaching and learning to develop critical thinking and practical skills. *Journal of Physics: Conference Series*, *1233*(1), 1–7. https://doi.org/10.1088/1742-6596/1233/1/012102

Toh, T. L., Cheng, L. P., Ho, S. Y., Jiang, H., & Lim, K. M. (2017). Use of comics to enhance students' learning for the development of the twenty-first century competencies in the mathematics classroom. *Asia Pacific Journal of Education*, *37*(4), 437–452. https://doi.org/10.1080/02188791.2017.1339344

Toheri, Winarso, W., & Haqq, A. A. (2020). Where exactly for enhance critical and creative thinking: The use of problem posing or contextual learning. *European Journal of Educational Research*, *9*(2), 877–887. https://doi.org/10.12973/eu-jer.9.2.877

Trilling, B., & Fadel, C. (2009). *21st century skills: Learning for life in our times*. Jossey Bass. https://doi.org/978-0-470-47538-6

Trimurtini, Ahmadi, F., Liftiah, & Widihastrini, F. (2020). Mobile learning media — "Jarak , Waktu Dan Kecepatan" as a medium to introduce problem-solving to children. *International Journal of Scientific & Technology Research*, *9*(2), 4246–4249.

Watson, G., & Glaser, E. (2002). *Watson-Glaser critical thinking appraisal, UK edition : Practice test*. Psychological Corporation.

Widana, I. W., Parwata, I. M. Y., Parmithi, N. N., Jayantika, I. G. A. T., Sukendra, K., & Sumandya, I. W. (2018). Higher order thinking skills assessment towards critical thinking on mathematics lesson. *International Journal of Social Sciences and Humanities*, *2*(1), 24–32. https://doi.org/10.29332/ijssh.v2n1.74

Widyatiningtyas, R., Kusumah, Y. S., Sumarmo, U., & Sabandar, J. (2015). The impact of problem-based learning approach to senior high school students' mathematics critical thinking ability. *Indonesian Mathematical Society Journal on Mathematics Education*, *6*(2), 30–38. https://doi.org/10.22342/jme.6.2.2165.107-116

Widyawati, A., & Prodjosantoso, A. K. (2015). Pengembangan media komik IPA untuk meningkatkan motivasi belajar dan karakter peserta didik SMP [Developing science comic to improve the science learning motivation and character of grade VIII students]. *Journal of Science Education Innovation/ Jurnal Inovasi Pendidikan IPA*, *1*(1), 24–35. https://doi.org/10.21831/jipi.v1i1.4529

Wijayanti, R., Hasan, B., & Loganathan, R. K. (2018). Media comic math berbasis whiteboard annimation dalam pelajaran matematika [Comic math media based on whiteboard animation in math]. *Mathematics Education Research Journal/ Jurnal Riset Pendidikan Matematika*, *5*(1), 53–63.

Wuryani, M. T., Roemintoyo, & Yamtinah, S. (2018). Textbooks thematic based character education on thematic learning primary school: An influence. *International Journal of Educational Methodology*, *4*(2), 75–81. https://doi.org/10.12973/ijem.4.2.75

Yadav, D. K. (2017). Exact definition of mathematics. *International Research Journal of Mathematics, Engineering and IT*, *4*(1), 34–42.

Yayuk, E., Purwanto, As'ari, A. R., & Subanji. (2020). Primary school students' creative thinking skills in mathematics problem solving. *European Journal of Educational Research*, *9*(3), 1281–1295. https://doi.org/10.12973/eu-jer.9.3.1281

Yudha, A., Sufianto, S., Damara, B. E. P., Taqwan, B., & Haji, S. (2019). The impact of contextual teaching and learning (CTL) ability in understanding mathematical concepts. *Advances in Social Science, Education and Humanities Research, 295*, 170-173. https://dx.doi.org/10.2991/icetep-18.2019.42