RANGE : Jurnal Pendidikan Matematika
e-ISSN :2685-2373
Volume 6, Nomor 1, Juli 2024, pp. 39-48

Problem Based Learning Models Assisted by Mathcard on Students' Critical Thinking Abilities and Mathematical Dispositions

Firda Nur Arifa[1]*, Syita Fatih 'Adna[2], Aprilia Nurul Chasanah[3]
[1,2,3]Department of Mathematics Education, Universitas Tidar, Magelang, Jawa Tengah, Indonesia
*Correspondence: firdanurarifa@gmail.com

Received: November 24th, 2023. Accepted: May 13th, 2024. Published: July 30th, 2024.

ABSTRACT

Learning using the 2013 curriculum encourages students to have 4C abilities. The findings of the initial test results in class IX of SMP Negeri 3 Muntilan, their critical thinking skills were classified as poor. Mathematical disposition abilities influence the low and high level of students' mathematical critical thinking abilities. The findings from the initial questionnaire showed that mathematical disposition ability was in the medium category. Then, with the need for students not to get bored quickly and to be active when learning, the Problem Based Learning (PBL) model assisted by math cards was implemented. The research objective to be achieved in this study is to analyze in a multivariate way the critical thinking abilities and mathematical disposition abilities taught using the PBL model assisted by mathcards are better than those taught using the expository learning model on quadratic equations. The approach used is quantitative research with a quasi experimental design in the form of a non equivalent posttest only control group design. The results of this research are; Multivariately, students' critical thinking abilities and mathematical disposition are better in the PBL model assisted by mathcards compared to the expository model in quadratic equations. However, educators need to reconsider the material that will be applied with this mathcard-assisted PBL model, because this model is not necessarily suitable for all material.

Keywords: *Critical Thinking, Mathematical Disposition, PBL*

How to Cite: Arifa, F.N.. (2023). Problem Based Learning Models Assisted by Mathcard on Students' Critical Thinking Abilities and Mathematical Dispositions. *Range: Jurnal Pendidikan Matematika*, 6 (1), 39-48.

Introduction

Education is very important for everyone. This is in accordance with findings from studies (Zhakilla, 2023) which show that education is very important in promoting the nation's progress. Since now, the government has had a new curriculum called the Independent Curriculum. Classes VII and VIII use this curriculum in junior high school. On the other hand, the curriculum used by class IX is the 2013 curriculum which was revised for 2017. The revised 2013 edition of the curriculum is an improvement on the 2013 curriculum which has several changes in content. The 2013 curriculum revision in 2017 requires teachers to provide four types of activities, which include character education, literacy, 4C, and HOTS (Laras et al., 2018). The implementation of the 2013 curriculum which was revised in 2017 is the government's effort to meet the needs of the 21st century.

It is important to have 4C skills as a strategy to achieve success, especially in the 21st century, when technology is developing at a very fast pace. Education based on the 2013-2017 revised curriculum

encourages the development of four critical competencies needed in the 21st century: Critical Thinking and Problem Solving (critical news and being able to solve problems), Communication (communication), and Collaboration (cooperation) (Sholikha & Fitrayati, 2021). Therefore, 4C is very important for the nation's generation . A child who has good critical thinking skills in mathematics will find it easy to explain any mathematical problem. It is very important for students to have critical thinking skills to be able to handle difficult situations, especially those related to mathematics (Rachmantika & Wardono, 2019). The result of low critical mathematical thinking skills is that it has an adverse impact on students. Skills in critical thinking are essential in mathematics education to understand and analyze mathematical concepts or problems that require analysis and interpretation of the problem (Kurniawati et al., 2018). As a result, the ability to think critically about mathematical ideas must be possessed by student.

This learning model has the potential to negatively impact student strength and endurance. Based on initial observations made on class IX students at SMP Negeri 3 Muntilan, the learning used by the teacher is expository learning. In expository learning the teacher will lecture more. Meanwhile, the critical thinking skills and mathematical disposition of class IX students at SMP Negeri 3 Muntilan are still relatively low based on the results of the questionnaire distributed by researchers. The problem of students' low critical thinking skills is proven by the results of the initial critical thinking ability test which was carried out in 2 (two) classes. It was found that the average mathematical critical thinking ability was only 50.81 out of a maximum score of 100. This score was classified as being in the poor category according to (Pertiwi, 2020).

Seeing these conditions, an appropriate learning model is needed so that students' mathematical critical thinking skills become better. Choosing the right learning model can activate students' potential which will later improve their critical thinking abilities (Nuryanti et al., 2018). The Mathcard -assisted Problem Based Learning (PBL) model is a problem-based learning model that uses media in the form of problem cards regarding quadratic equations. The mathcard -assisted PBL model invites students to be active when mathematics learning takes place. The Problem Based Learning (PBL) model is based on problem situations that can arouse students' curiosity and involve students in investigations (Puspitawedana & Jailani, 2017). The use of problem-based cards " Mathcard" is expected to attract students' attention so they are active when learning. The question cards display problems in a unique form so as to enliven the student's learning atmosphere (Kusumawardani & Maryatun, 2018). Mathcard -assisted PBL is expected to be more interesting because it presents quadratic equation problems in a unique form compared to the expository learning model which tends to be teacher-centred so that students quickly get bored.

Mathcard -assisted PBL learning model , there are other factors that influence students' low and high critical thinking abilities. Mathematical disposition abilities are needed by students to face questions or problems related to mathematics. Students need mathematical disposition skills to be able to survive in facing problems, be responsible for their learning, and apply good work habits in learning mathematics (Sa'adah & Zanthy, 2019). So that mathematical disposition influences the low and high levels of students' mathematical critical thinking abilities. Apart from critical thinking skills, mathematical disposition has an important role in achieving learning goals (Mardiah et al., 2020). A low mathematical disposition results in a lack of perseverance when studying mathematics, not being serious about doing assignments and activities related to mathematics, as well as a low assumption that mathematics is beneficial for students. The average mathematical critical thinking ability was 51.40 for the experimental class and 54.06 for the control class. This score is in the medium category (Herutomo & Masrianingsih, 2019).

Based on the description above, a Mathcard -assisted Problem Based Learning model is needed to develop students' critical thinking skills and dispositions regarding quadratic equation material. Therefore, researchers are interested in researching more deeply regarding "Experimentation of the Problem Based Learning Model Assisted by Mathcard on the Critical Thinking Ability and Mathematical Disposition of Class IX Students".

Methods

The type of research used in this research is quantitative research with a quasi-experimental research design in the form of a non-equivalent posttest only control group design and data analysis by comparing the initial ability results with the post-test results of the experimental class and control class. The experimental class is a class that is taught using the Mathcard- assisted Problem Based Learning (PBL) model , while the control class is a class that receives learning using an expository learning model **.**

The population is the research target in the form of all subjects or objects that have certain characteristics. Meanwhile, the sample is a number of things researched or observed that are relevant to the problem in the research and have characteristics like the population (Sundayana, 2018).

The population in this study is all 220 class IX students of SMP Negeri 3 Muntilan for the 2023/2024 academic year who are divided into 7 classes, namely A, B, C, D, E, F, and G. This population has homogeneous characteristics because there are no superior classes, which then selected classes to be used as samples for this research.

The sample in this study was taken based on a random sampling technique type of cluster sampling (conditional sampling) , where the population is spread out (Sundayana, 2018). Based on the population

of all class IX of SMP Negeri 3 Muntilan, two classes IX C were selected as the experimental class and IX D as the control class.

The research instruments used in this research are as follows. The learning tool instrument is a lesson plan prepared using the PBL model and mathcard learning media. The test instrument is a critical thinking ability test. Questionnaire instrument, in the form of a mathematical disposition ability questionnaire . Instrument data analysis uses validity, reliability, level of difficulty and difference analysis . Based on the results of the validity analysis, the conclusion obtained was that the test questions were declared very valid because the Aiken's V index value = 0.84. Based on the validity analysis of the questionnaire contents, the conclusion obtained was that the test questions were declared very valid because the Aiken's V index value = 0.83. From the results of the analysis of the construct validity of the questions above, the conclusion obtained is that the test questions are declared very valid. The results of the reliability analysis of the questions show that the test questions are declared reliable with high criteria, including in the range $0{,}60 \leq r < 0{,}80$because the reliability coefficient is 0.72. The results of the reliability analysis show that the test questions are declared reliable with very high criteria, including in the range $0{,}60 \leq r < 0{,}80$because the reliability coefficient is 0.91. Meanwhile, the results of the difficulty level analysis show that the test questions have a moderate/fair level of difficulty. So the questions are good questions to use. Furthermore, the results of the differential power analysis of test questions in this study show that all test questions are in the sufficient category. So the test questions are included in the questions that are good to use. Analysis of the research data used was the multivariate normality test, the multivariate homogeneity test, and the multivariate mean difference test.

Results and Discussion

The two classes that will be given treatment in the form of a learning model will first be tested for their initial abilities. Student initial ability data is divided into two, namely; initial data for the experimental class and initial data for the control class.

Table 1. *Initial Data Description*

Class	n_i	Ability	X_{maks}	X_{min}	$\bar{X}$
Experiment	32	CBC	75	38	49.87
		KDM	65	36	51.40
Control	32	CBC	71	50	51.41
		KDM	63	43	54.06

Information:
KBK = critical thinking skills
KDM = mathematical disposition ability

Table 1 shows a description of the initial data with the number of students in each class, both experimental and control, being 32 children. The average critical thinking ability of the experimental class was 49.87 while the control class was 51.41, higher than the control class. Similar to critical thinking abilities, the average of the control class is also higher than the experimental class. The control class obtained an average mathematical disposition ability of 51.40 while the experimental class obtained 54.06.

Before testing the hypothesis, prerequisite testing is first carried out. The first prerequisite test is the normality test. The multivariate normality test is used to determine whether the initial data is normally distributed or not. The significance level used in this multivariate normality test is 0.05. This multivariate normality test produces squared distances (d_j^2) which are then sorted from smallest to largest. The number of squared distances (d_j^2) that were less than or equal to those $\chi^2_{0.05,2} = 1{,}39$in the experimental class was 21, while in the control class there were 17. Thus, it can be seen if the data is less than or equal to $\chi^2_{0.05,2} = 1{,}39$more than 50% of the data. So H_0it is accepted, both classes have a normal distribution.

After the first prerequisite test is fulfilled, the second prerequisite test is continued, namely the homogeneity test. The multivariate homogeneity test is used to test whether the variance and covariance matrices in each population are the same or not. Multivariate homogeneity testing was carried out using the Box's M test. The results of the multivariate homogeneity test for initial ability data obtained a value $\chi^2_{obs}$of -370.946 and a value $\chi^2_{0,05;\,3}$of 7.815. The value $\chi^2_{obs} < \chi^2_{0,05;\,3}$, then H_0accepted, the variance and covariance matrices of the first population and the second population are the same.

After fulfilling the prerequisite tests for normality and homogeneity tests of the initial data, a multivariate mean difference test was then carried out. The multivariate mean difference test for initial data is used to determine whether the initial data in two populations has the same mean or not. The results of the multivariate mean difference test of the initial data are that the multivariate mean difference test of the initial data for the two classes is $F_{obs} = 0{,}694 < F_{0,05;2,61} = 3{,}15$. Thus, H_0it is accepted that, in multivariate terms, both classes have the same or balanced mean.

After carrying out treatment in the form of a PBL learning model in the experimental class and expository in the control class, students were given a post test related to KBK and KDM. The following is the final research data.

Table 2. *Final Data Description*

Class	Ability	n_i	X_{maks}	X_{min}	$\bar{X}$
Experiment	CBC	32	100	63	83.94
	KDM		68	57	60.88
Control	CBC	32	90	53	71.38
	KDM		67	44	55.69

Information:

KBK = Critical thinking skills

KDM = Mathematical disposition ability

Table 2 shows a description of the initial data with the number of students in each class, both experimental and control, being 32 children. The average critical thinking ability of the experimental class was 83.94, while the mathematical disposition ability was 60.88. Meanwhile, the control class got an average critical thinking ability of 71.38 and 55.69 for mathematical disposition ability. So the average critical thinking ability and mathematical disposition of the experimental class is superior to the control class.

Before testing the hypothesis, prerequisite testing is first carried out. The first prerequisite test is the normality test. The multivariate normality test is used to determine whether the final data from the post test is normally distributed or not. The significance level used in this multivariate normality test is 0.05. This multivariate normality test produces squared distances (d_j^2) which are then sorted from smallest to largest. The results of the final multivariate normality test showed that the number of squared distances (d_j^2) that were less than or equal to those $\chi^2_{0,05;2} = 1{,}39$in the experimental class was 16, while in the control class there were 24. The table above shows that in the experimental class the number of squared distances that were less than or equal to $X^2_{0,05;2} = 1{,}3916$ or 50% of the data, while in the control class there were 24 or more than 50% of the data. So H_0it is accepted, both classes have a normal distribution.

After the first prerequisite test is fulfilled, the second prerequisite test is continued, namely the homogeneity test. The multivariate homogeneity test is used to test whether the variance and covariance matrices in each population are the same or not. Multivariate homogeneity testing was carried out using the Box 's M test. The results of the multivariate homogeneity test for initial ability data are as follows.

Table 3. *Final Data Homogeneity Test Results*

Class	n_i	v_i	v_e	χ^2_{obs}	$\chi^2_{0,05;3}$	Decision
Experiment	32	31	62	$-216{,}85$	7,815	H_0accepted
Control	32	31				

The table above shows that the obtained value $\chi^2_{obs}$is -216.85 and the value $\chi^2_{0,05;\,3}$is 7.815. The value $\chi^2_{obs} < \chi^2_{0,05;\,3}$, then H_0accepted, the variance and covariance matrices of the first population and the second population are the same.

After fulfilling the prerequisite tests for normality and homogeneity tests of the initial data, a multivariate mean difference test was then carried out. The multivariate mean difference test for initial data is used to determine whether the initial data in two populations has the same mean or not. The results of the multivariate mean difference test of the initial data are as follows.

Table 4. Final Data Homogeneity Test Results

Class	n_i	F_{obs}	$F_{0,05;2,61}$	Decision
Experiment	32	83.94	3.15	H_0 rejected
Control	32			

The table above shows that the multivariate mean difference test of the initial data for the two classes is $F_{obs} = 83,94 > F_{0,05;2,61} = 3,15$. Thus H_0it is rejected, in multivariate terms the two classes have unequal means.

The final data multivariate mean difference test showed that the results H_0were rejected, meaning that in multivariate terms the two classes had different means. Thus, it can be continued with further tests in the form of separate univariate tests for critical thinking and mathematical disposition variables. This test is carried out with a test t.

Table 5. *Univariate Mean Difference Test of Critical Thinking Ability*

Class	n	$\bar{X}$	s^2	t_{obs}	$t_{0,025;61}$	Decision
Experiment	32	83.94	127.48	4.76	1,999	$H_o$rejected
Control	32	71.38	95.21			

The table above shows that the t test results for critical thinking abilities for both classes are $|t_{hit}| = 4,76 > t_{tabel} = 1,999$at a significance level of 0.05 and $H_0$are rejected. Thus, the critical thinking abilities produced by the mathcard -assisted PBL model are not the same as the critical thinking abilities produced by the expository model. Therefore, observations were made on the average scores obtained by the two classes. Based on table 4.13 $\bar{X}_{eksperimen} = 83,94 > \bar{X}_{kontrol} = 71,38$, it can be concluded that critical thinking skills taught using the PBL model assisted by mathcards are better than those taught using the expository learning model.

Table 6. *Univariate Mean Difference Test of Mathematical Disposition Ability*

Class	n	$\bar{X}$	s^2	t_{obs}	$t_{0.025,61}$	Decision
Experiment	32	60.88	9.40	5.21	1,999	$H_o$rejected
Control	32	55.69	22.29			

The table above shows that the t test results for the mathematical disposition abilities of both classes are $|t_{hit}| = 5{,}21 > t_{tabel} = 1{,}999$at a significance level of 0.05 and $H_0$are rejected. Thus, the mathematical disposition abilities produced by the mathcard -assisted PBL model are not the same as the mathematical disposition abilities produced by the expository model. Therefore, observations were made on the average scores obtained by the two classes. Based on table 4.13, $\bar{X}_{eksperimen} = 60{,}88 > \bar{X}_{kontrol} = 55{,}69$it can be concluded that the mathematical disposition abilities taught using the PBL model assisted by mathcards are better than those taught using the expository learning model.

The critical thinking abilities and mathematical disposition of students taught using the PBL model assisted by mathcards are better than those taught using the expository model. This is based on further tests using univariate tests for each variable, both of which resulted in H_0rejection and the average of both learning abilities was higher when taught using the Mathcard-assisted PBL model. Apart from the results of these further tests, the mathcard -assisted PBL model is superior in developing students' critical thinking skills and mathematical disposition abilities because the mathcard -assisted PBL model makes students more active and does not get bored quickly. This statement is supported by findings during research implementation.

Learning in the experimental class is carried out in groups by applying the PBL model with the help of mathcards. There are eight groups, each group consisting of 4 students. Learning is carried out in groups so that students are more active and enthusiastic when learning. In line with research(Arta et al., 2020) who said that the PBL model can make students independently more active and enthusiastic when learning.

When learning in class, students look more enthusiastic with the help of mathcards. With the PBL model assisted by mathcards, the learning atmosphere feels more lively. The question cards display problems in a unique form so as to enliven the student's learning atmosphere (Kusumawardani & Maryatun, 2018). Learning supporting media is needed to support the success of the learning process. With learning media the learning process becomes interesting and more effective and efficient. This is in line with research (Nurfadhillah et al., 2021)which states that one of the benefits of learning media is that the learning process will be more effective and efficient. Mathcard helps encourage students to always try to solve problems even though they seem difficult. By working in groups, students can exchange ideas to find answers to the questions. This trains students' self-confidence, flexibility, persistence, curiosity and

reflectivity towards mathematics. In line with research Lintang dkk. (2023) which says that students become less active when learning because they fail to solve problems, so the PBL model assisted by mathcards can be one solution to overcome this. Based on all the stages of the mathcard-assisted PBL model, the stages that have a greater influence on critical thinking abilities and mathematical disposition are the problem presentation and guidance and investigation stages. At the problem presentation stage, students in groups are given problems in the form of mathematical questions about quadratic equations. Meanwhile, at the guidance and investigation stage, the teacher guides the students and their groups to discuss looking for answers to the questions that have been given. So the teacher acts as a facilitator.

In contrast to the experimental class, the control class uses a teacher-centered expository learning model. The process of conveying knowledge by teachers to students so that learning is teacher-centered so that the classroom atmosphere tends to be less lively. Before the lesson is finished the teacher gives practice questions that the students have to work on. However, in reality there are students who only write questions because they feel they cannot do the questions. Apart from that, research shows that students who feel bored with the learning atmosphere tend to be lazy in doing the assignments given by the teacher. Thus, learning becomes less effective and efficient.

Conclusion

Based on the results of the research and discussion above, the conclusion in this research is that in multivariate terms critical thinking abilities and mathematical disposition abilities taught using the Problem Based Learning (PBL) model assisted by mathcards are better than critical thinking abilities and mathematical disposition abilities taught using the learning model. expository on quadratic equations material.

Based on the research results and implications above, the suggestions given are as follows. The Problem Based Learning (PBL) model assisted by math cards can be used as a solution to develop students' critical thinking skills and mathematical disposition in learning mathematics regarding quadratic equations. On the other hand, teachers need to reconsider the material that will be applied with this mathcard- assisted PBL model , because this model may not necessarily be suitable for other materials and the conditions of each student. In this mathcard -assisted PBL learning model , students should be more active in learning, because in this learning students are encouraged to work together with their group of friends. It is hoped that future researchers will be able to develop this research with various additional variables or change existing variables with other variables they wish to research.

Bibliography

Arta, I., Japa, I. G., & Sudarma, I. K. (2020). Problem Based Learning Berbantuan Icebreaker Berpengaruh Terhadap Kemampuan Pemecahan Masalah Matematika. *Mimbar PGSD Undiksha*, *8*(2), 264–273. https://doi.org/https://doi.org/10.23887/jjpgsd.v8i2.25435.

Herutomo, R. A., & Masrianingsih, M. (2019). Pembelajaran model creative problem-solving untuk mendukung higher-order thinking skills berdasarkan tingkat disposisi matematis. *Jurnal Riset Pendidikan Matematika*, *6*(2), 188–199. https://doi.org/10.21831/jrpm.v6i2.26352

Kurniawati, D., Ekayanti, A., Keguruan, F., Pendidikanuniversitas, I., & Ponorogo, M. (2018). Pentingnya berpikir kritis dalam pembelajaran matematika. *Jurnal Pendidikan Tambusai , 2(2)*, 793–801. https://doi.org/10.31604/ptk.v3i2.107-114

Kusumawardani, E. D., & Maryatun. (2018). Meningkatkan kemampuan menyimpulkan matematik dan percaya diri melalui pbl berbantuan kartu soal siswa kelas X. *PRISMA: Prosiding Seminar Nasional Matematika*, 92–98.

Laras, Purwaningsih, E., & Warneri. (2018). Kesiapan guru ekonomi terhadap 9 perubahan kurikulum 2013 revisi 2017 di sman 9 pontianak. *Jurnal Pendidikan Dan Pembelajaran Khatulistiwa (JPPK)*, *7(9)*, 1–9. https://doi.org/http://dx.doi.org/10.26418/jppk.v7i9.28927.

Lintang, L., Armanto, D., & Mansyur, A. (2023). Pengembangan Lembar Kerja Peserta Didik Berbasis Model Problem Based Learning untuk Meningkatkan Kemampuan Pemecahan Masalah dan Disposisi Matematis Siswa. *Jurnal Cendekia : Jurnal Pendidikan Matematika*, *7*(2), 1225–1239. https://doi.org/10.31004/cendekia.v7i2.2331

Mardiah, Fauzan, A., Fitria, Y., Syarifuddin, H., & Desyandri. (2020). Pengaruh pendekatan realistic mathematic education terhadap pemahaman konsep dan disposisi matematis siswa sekolah dasar. *Jurnal Basicedu*, *4*(2), 513–521. https://doi.org/https://doi.org/10.31004/basicedu.v4i2.340

Nurfadhillah, S., Ramadhanty Wahidah, A., Rahmah, G., Ramdhan, F., Claudia Maharani, S., & Muhammadiyah Tangerang, U. (2021). Penggunaan media dalam pembelajaran matematika dan manfaatnya di sekolah dasar swasta plus ar-rahmaniyah. *EDISI : Jurnal Edukasi Dan Sains*, *3*(2), 289–298. https://ejournal.stitpn.ac.id/index.php/edisi

Nuryanti, L., Zubaidah, S., & Diantoro, M. (2018). Analisis Kemampuan Berpikir Kritis Siswa SMP. *Jurnal Pendidikan*, *3(2)*, 155–158. https://doi.org/http://dx.doi.org/10.17977/jptpp.v3i2.10490.

Pertiwi, W. (2020). Analisis kemampuan berpikir kritis matematis peserta didik smk pada materi matriks. *PeTeKa (Jurnal Penelitian Tindakan Kelas Dan Pengembangan Pembelajaran)*, *2(4)*, 107–114. https://doi.org/DOI : 10.31604/ptk.v3i2

Puspitawedana, D., & Jailani. (2017). *Perangkat pembelajaran matematika menggunakan model problem based learning untuk meningkatkan higher order thinking skill siswa.* Parama Publishing.

Rachmantika, A. R., & Wardono, W. (2019). *Peran kemampuan berpikir kritis siswa pada pembelajaran matematika dengan pemecahan masalah*. 439–443.

Sa'adah, S., & Zanthy, L. S. (2019). Pengaruh Disposisi Matematis Terhadap Kemampuan Berpikir Kritis Pada Siswa SMP. *Journal On Education*, *1(3)*, 405–410. https://doi.org/https://doi.org/10.31004/joe.v1i3.181

Sholikha, S. N., & Fitrayati, D. (2021). Integrasi Keterampilan 4C dalam Buku Teks Ekonomi SMA/MA. *EDUKATIF : Jurnal ilmu pendidikan*, *3*(5), 2402–2418. https://doi.org/10.31004/edukatif.v3i5.823

Sundayana. (2018). *Statistika Penelitian Pendidikan*. Bandung: Alfabeta.

Zhakilla, F. N. (2023). Efektifitas Penggunaan Media Kartu Bilangan Pada Materi Operasi Bilangan Untuk Meningkatkan Motivasi Belajar. *Range: Jurnal Pendidikan Matematika*, *4*(2), 152–163. https://doi.org/https://doi.org/10.32938/jpm.v4i2.3423.