The Model of Based-Problem Learning, Students Problem-Solving Skills and Characteristics of Thinking Way

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Article Info

Article history:

Received Feb 1, 2020
Revised Apr 5, 2020
Accepted Jun 9, 2020

Keywords:

Problem Based Learning
Problem Solving Ability
Characteristics Way of Thinking

ABSTRACT

This study aims to determine the differences in student's problem-solving abilities through the Problem Based Learning (PBL) model and the direct learning model, the differences in students' problem-solving abilities through the PBL model, and the direct learning model in terms of the characteristics of the way of thinking. This study used a quasi-experimental method with a two-way ANOVA design. The sample in this study was the fifth-semester students of class A and B IKIP PGRI Pontianak using the cluster random sampling technique. The used research instrument was a test of problem-solving ability in discrete mathematics courses and a questionnaire on the characteristics of the way of thinking. This study resulted in a difference between student's problem-solving abilities through the PBL model and the direct learning model. The results showed that there were no differences in students' problem-solving abilities through the PBL model and the direct learning model in terms of the characteristics of both the way of thinking, the way of thinking in Concrete Sequences (CS), Sequences Abstract (SA), Concrete Random (CR), or Abstract Random (AR).

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1. INTRODUCTION

Problem-solving is an important aspect of learning mathematics because mathematical problems cannot be separated from the problem-solving process. Mukasyaf et al. (2019), Nugraheni et al. (2014) Oktaviana and Susiaty (2020) state that problem-solving ability is one of the most important abilities that students must have in solving a problem. Besides, Tambychik and Meerah (2010) stated that problem-solving is a very important aspect in the application and integration of mathematical concepts and also in the ability to make decisions. Based on this, it can be said that problem-solving is very important in learning.

Problem-solving is an effort to find solutions to complex problems and of course, the intended solution is not easy to find (Hobri et al., 2020; Memnun et al., 2012). Problem-solving abilities are closely related to students' abilities to read and understand the meaning of problems, model problems in mathematical models, and doing calculations on uncommon problems (Anisa, 2014). The process is a stage of solving Polya's problem which consists of 4 stages, consists of (1) write down in your language what is known and asked about, and classify important and unimportant information to be used as a method or strategy; (2) make a written plan or idea that will be used to solve the problem; (3) answer the questions with plans that have been made previously; (4) recheck each problem-solving step (see or reflect) the correctness of the answers obtained, and make modifications if possible (Fahrudin et al., 2019).

But in reality, there are still students who have low problem-solving abilities. This is in line with several studies which state that problem-solving abilities are very low (Ambarwati, 2016; Son et al., 2020). Putra et al. (2018) states that low problem-solving abilities are a major factor in the difficulty of students understanding information, errors in concluding problems caused by difficulties in the problem-solving process. Oktaviana et al. (2020) state that students are still not skilled in solving problems from questions because students have difficulty applying the material taught with the knowledge that has been obtained and applying it. This condition is also similar to students when taking lectures on discrete mathematics courses.

Discrete Mathematics (DM) is a mathematics education course that emphasizes problem-solving. The DM course contains more abstract problem-solving problems. Based on the results of observations, the process of solving students in solving problems still found many errors. The mistakes that have been made by students include reading and understanding questions, transforming errors, processing skills, and writing final answers where students cannot form or design problem solving (Oktaviana, 2018). These errors are summarized in problem-solving abilities. If this problem is given it will have an impact on students' final grades. This is in line with the research of Arjudin, Sutawdjaja, Irawan, & Sa'adijah, 2016 which states that mathematical problem-solving abilities must be a concern so that it can be followed up from a research result. Therefore, problem-solving skills need to be improved through a learning model.

One of the many learning models that emphasize problem-solving and lead students to find their concepts is the Problem Based Learning (PBL) model. This model is a model based on constructivism theory. This learning idea is based on constructive, collaborative, contextual, and self-learning assessment (Zwaal, 2019). According to Susanto & Retnawati (2016), the characteristic of problem-based learning is learning that begins with a problem. Oguz-unver and Arabacioglu (2011) state that the main principle of PBL is to maximize the role of learning by investigating, explaining, and solving contextual and meaningful problems. The emphasis of students to think critically in the process of finding real-world problem solutions is the goal of problem-based learning activities (Jensen et al., 2019).

There are six core characteristics of problem-based learning: 1) student-oriented; 2) students are grouped into small groups; 3) the teacher acts as a facilitator; 4) authentic problems in learning; 5) problems are used to acquire knowledge and skills when solving mathematical problems; and 6) through independent learning students obtain information (Mann et al., 2020). By being given this learning, it is thought that it can improve students' problem-solving abilities.

Several studies have revealed that the PBL model has been able to improve problem-solving abilities, including (1) Yew and Goh, (2016), research which states that problem-based learning with scaffolding has achieved the desired results, namely the development of problem-solving abilities; (2) Klegeris and Hurren (2011), the use of the PBL model has been able to improve students' problem-solving abilities; and the PBL model emphasizes problem-solving activities in learning so that it can hone students' thinking skills (Gunantara et al., 2014; Rahmadani & Anugraheni, 2017).

Apart from the learning model, other factors also affect problem-solving abilities, namely the characteristics of students' thinking. The characteristics of this way of thinking are the typical way a person organizes and processes information in the cognitive field. (DePotter & Hernacki, 2016) have distinguished ways of thinking into four types, namely: concrete sequence (CS), abstract sequence (AS), concrete random

(CR), and abstract random (AR). The way of thinking greatly affects the success of students in solving math problems in their way and the abilities they have in mind (Dick & Carey, 2005). A teacher should be able to recognize and know student characteristics because a good understanding of student characteristics will greatly affect the success of student learning.

Based on the description previously described, this study aims to determine whether there are differences in student problem-solving abilities through the Problem Based Learning (PBL) model and the direct learning model, differences in student problem-solving abilities through the PBL model with direct learning models in terms of the characteristics of the way of thinking in DM course.

2. RESEARCH METHOD

This research has been carried out in the Mathematics Education study program of IKIP PGRI Pontianak. The sample in this study were students in the fifth semester who were taking discrete mathematics lectures in two out of four classes. Sampling was done by using the cluster random sampling technique, which is taking samples randomly where before the sample is taken, the homogeneity test is done first and where the variance of the population is homogeneous. Based on this technique, it was obtained that class B as the experimental class amounted to 25 students and class A as the control class amounted to 27 students.

This study used a quasi-experimental research method with a two-way ANOVA research design with the design in Table 1.

Table 1. Research Factorial Design

Learning model	Characteristics Way of Thinking			
	B_1	B_2	B_3	B_4
A_1	A_1B_1	A_1B_2	A_1B_3	A_1B_4
A_2	A_2B_1	A_2B_2	A_2B_3	A_2B_4

In Table 1, code A_1 is a PBL learning model and code A_2 is direct learning, while code B_1 is CS thinking, B_2 is CS thinking, B_3 is CR thinking, and B_4 is AR thinking. Researchers have collected data for hypothesis testing as many as 6 times meetings in the experimental class and control class. The research flow carried out is shown in Figure 1.

First, the test questions were carried out before being given the test to students. Before being tried out, the test questions were validated first by two validators, namely a lecturer in the mathematics education study program at the IKIP PGRI Pontianak where valid criteria were obtained. After that, the test questions were tried out to analyze the questions and obtain valid and reliable questions. Then the implementation of the research was carried out by providing a questionnaire on the characteristics of the way of thinking and pretest questions in advance both in the experimental class and the control class. At the end of the meeting, after the treatment, the researcher gave a posttest which aimed to see the results of the treatment that had been given.

The data collection techniques used in this study are measurement techniques and indirect communication techniques where the data collection instrument is a test of problem-solving abilities where the pretest and posttest questions are in the form of an essay which contains four indicators of problem-solving abilities and a characteristic questionnaire of the way of thinking has been adopted from John Park de Tellier in DePotter & Hernacki. To find out if a student is included in the characteristics of the way of thinking is done by adding the answers in column I, II, III, and IV and then multiplying by four in each column, then the box and the largest number show the student's way of thinking.

In data analysis technique. Before the treatment, a balance test was carried out to determine the similarity of the mean initial ability between the two classes using the t-test. Where previously prerequisite tests were carried out including normality tests and homogeneity tests which were processed using the SPSS program. If the prerequisite test is normally distributed and homogeneous, it uses two-way ANOVA and if the prerequisite test is one of the data that is not normally distributed or homogeneous, then use the Kruskal Wallis k-independent sample test. The data used in this research is data gain.

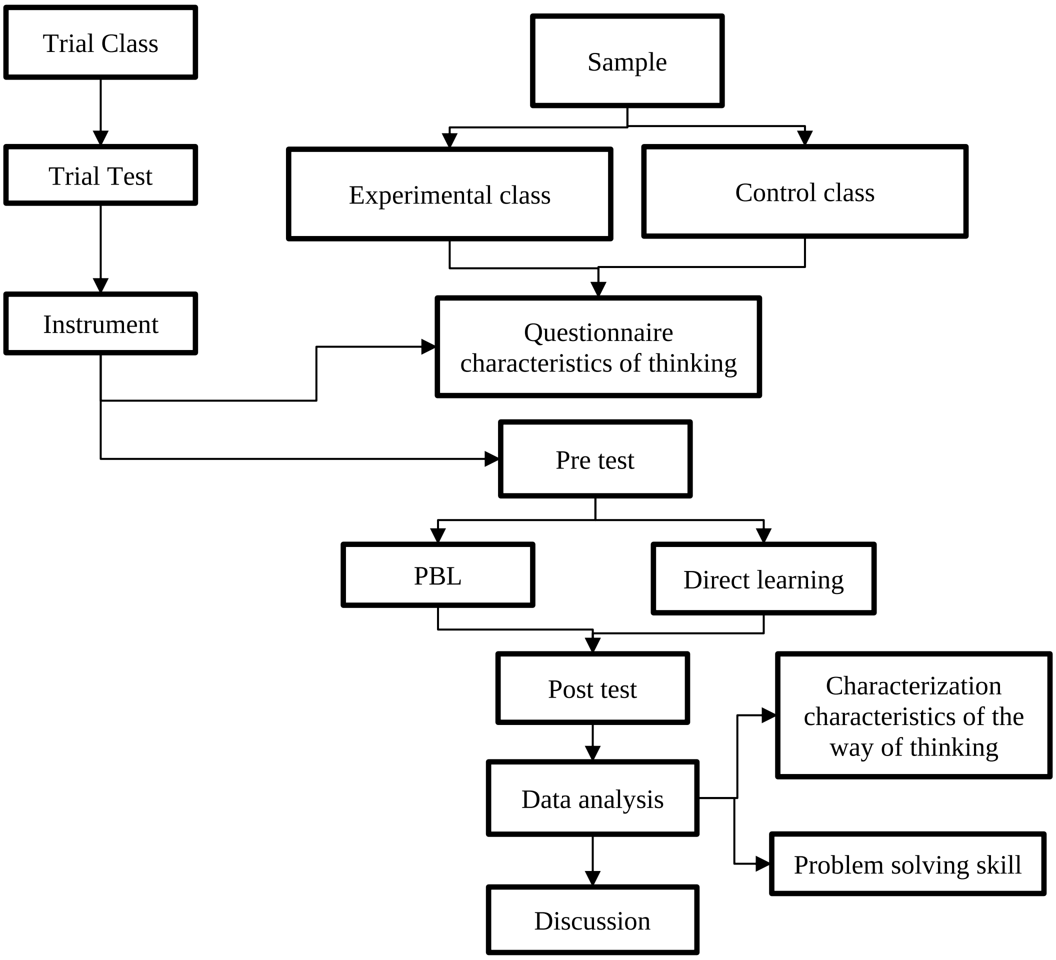

Figure 1. Research Flowchart

3. RESULTS AND DISCUSSION

Before the research was carried out, the researcher conducted a balance test on the research sample. The data that have been used in this balancing test is the results of the discrete mathematics final exam in the previous semester. The purpose of the balance test is to find out that the research sample is in the same or balanced condition so that the resulting changes are the result of experiments conducted by researchers. Before the balance test was carried out using the t-test, the researcher first carried out the prerequisite test for the normality and homogeneity test. The results of homogeneity and normality can be seen in Tables 2 and 3 below.

Table 2. Initial Ability Data Normality Test

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experimental class value	.142	25	.200*	.947	25	.214
Control class value	.160	25	.098	.956	25	.340

Table 3. Initial Ability Data Variance Homogeneity Test

Levene Statistic	df1	df2	Sig.
.004	1	50	.953

Based on Table 2, it has been obtained that the significance value of the Shapiro-Wilk in the experimental class is 0.214 and in the control, the class is 0.34 so that the significant value of the two classes is more than 0.05 so that the initial ability data of students is normally distributed. Meanwhile, Table 3 shows the significant value of the experimental and control class students' initial ability of 0.953 which is more than 0.05 so that the initial ability data of students are homogeneous. Thus it can be continued to the balance test with the t-test. The results of the balance test can be seen in Table 4 below.

Table 4. Initial Data Balance 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
final exams value	Equal variances assumed	.004	.953	1.659	50	.103	10.044	6.053	-2.114	22.203
	Equal variances not assumed			1.655	49.076	.104	10.044	6.067	-2.148	22.237

Based on Table 4, it has been obtained that the significant value (2-tailed) is 0.103 where the Sig. (2-tailed) more than 0.05, the research sample is in the same or balanced state so that it can be concluded that the results of the study later are a result of the experiments carried out in the study because before being treated the two groups were in the same or balanced condition.

Furthermore, the researcher analyzed the data related to the research results. Before giving treatment to the experimental and control classes, the researcher gave a questionnaire to the students' thinking characteristics first to classify students into 4 types of thinking, namely concrete sequence (CS), abstract sequence (AS), concrete random (CR), and abstract random (AR). The classification of the results of the questionnaire characteristics of the way of thinking is seen in Table 5 below.

Table 5. Classification Of The Results Of The Student Thinking Word Questionnaire

	characteristics of way of thinking			
	CS	AS	CR	AR
number of students	17	9	22	4

Based on Table 5, it can be seen that the most dominant characteristic of student way thinking is the abstract random way of thinking or AR and the least way of thinking is the type of concrete random thinking or CR.

The sample in this study consisted of two classes, namely the experimental class by applying the PBL model and the control class by applying direct learning. The average pretest and posttest results can be seen in Table 6 below.

Table 6. Mean Of Pretest And Posttest Results For Experiment And Control Classes

Class	Average		Step-Up
	Pretest	*Posttest*	
Experiment	39,3	83,2	43,9
Control	31,02	70,93	39,91

Based on Table 6, it can be seen that the pretest and posttest data of students have a significant difference where the pretest data for the experimental class is 39.3 and the control class is 31.02, while the posttest data for the experimental class is 83.2 and the control class is 70.93. This shows that the PBL model applied to the experimental class is more effective than the control class which is given the direct learning model.

Next will be presented research data related to the average value of problem-solving abilities based on the characteristics of students' thinking. The mean data are presented in Figure 2 below.

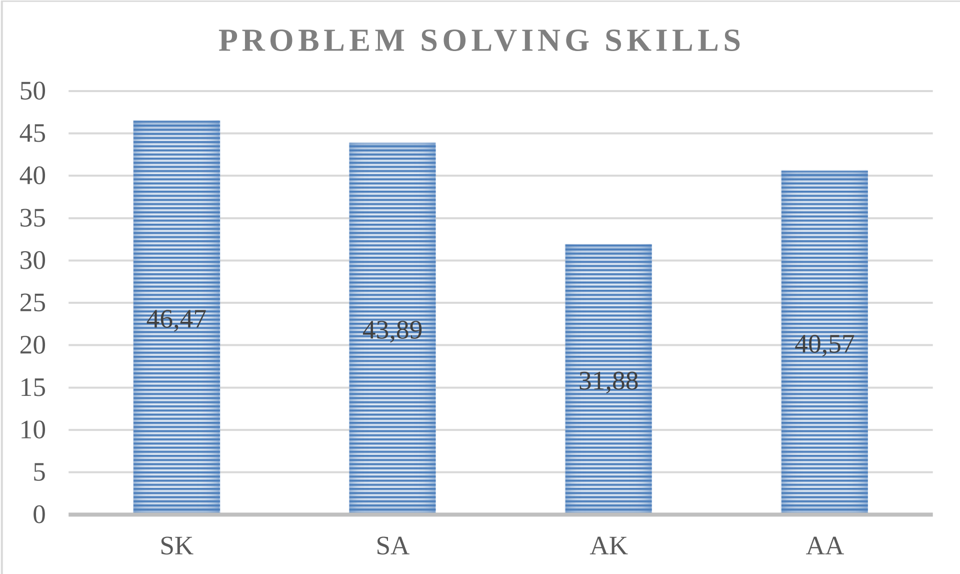

Figure 2. Average Problem Solving Ability in Each Type of Thinking

Based on Figure 2, it can be seen that the average SK type of thinking is 46.47, the average AS type of thinking is 43.89, the average AK type of thinking is 31.88, and the average AA type of thinking is 40.57. If we look through the average problem-solving ability of each type of thinking, there is no significant difference. However, the average problem-solving ability with the greatest increase was the increase in the SK type of thinking because students thought the SK type of thinking in solving problems in detail.

In this study, the independent variables used were the learning model and the characteristics of the way of thinking and problem-solving abilities as the dependent variable. Therefore, the analysis uses two-way ANOVA but before the ANOVA test is carried out, the ANOVA prerequisite test is carried out, namely the data must be normally distributed and homogeneous. Hypothesis testing process, the data used is data gain because researchers want to know the increase in problem-solving abilities after being given the PBL learning model and direct learning model. The results of the normality test and the homogeneity test of the gain data on the problem-solving ability can be seen in Table below.

Table 7. Normality Test Of Gain Data On Problem Solving Ability In The Learning Model Group

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Experiment	.145	25	.189	.960	25	.411
Control	.130	25	.200*	.964	25	.503

Table 8. Normality Test Of Gain Data On Problem Solving Ability In The Characteristics Of Thinking Group

	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
SK	.236	4	.	.911	4	.488
SA	.271	4	.	.897	4	.416
AA	.260	4	.	.827	4	.161
AK	.262	4	.	.895	4	.408

Table 9 . Homogeneity Test Of Gain Data On Problem Solving Ability In The Learning Model Group

Levene Statistic	df1	df2	Sig.
.017	1	50	.896

Table 10. Homogeneity Test Of Gain Data On Problem Solving Ability In Thinking Characteristics Group

Levene Statistic	df1	df2	Sig.
.639	3	48	.594

Based on Table 7 and Table 8, it has been found that the significance value of the Shapiro-Wilk in the learning model group and the characteristics group for the way of thinking has a significant value of more than 0.05 so that the data for the learning model group and the characteristic group for the way of thinking are normally distributed. However, based on Table 9 and Table 10, the significant value in the learning model group and the characteristic group of ways of thinking is more than 0.05 so that the data for the learning model group and the characteristic group of ways of thinking have the same variance (homogeneous), meaning that the two-way analysis of variance test requirements (ANOVA) to test the hypothesis has been fulfilled. Therefore, the hypothesis test will be followed by an ANOVA test with different cells. The summary of the results of ANOVA calculations can be seen in Table 11 below.

Table 11. Analysis Of Two Way Variance Of Problem Solving Ability

Source	JK	dk	RK	$F_{computation}$	F_{table}	Conclusion
Model (A)	16335,565	1	16335,565	149,57	3	H_{0A} Rejected
Way of thinking (B)	420,827	3	140,276	1,28	2,6	H_{0B} Accepted
Interaction (AB)	554,205	3	184,735	1,69	2,1	H_{0AB} Accepted
Error	4805,402	44	109,214	-	-	-
Total	22115,999	51	-	-	-	-

Based on Table 10, the Model (A) section shows that higher than which means rejected so it can be concluded that there is a difference in the increase in problem-solving abilities between students who are taught the PBL learning model and the direct learning model. When viewed through the average margin of the increase in student problem-solving abilities, the average increase in student problem-solving abilities taught through the PBL model was 43.9 higher than the average increase in problem-solving abilities of students taught using the direct learning model with a mean of 39.91. Thus, it can be concluded that the increase in student problem-solving abilities given the PBL learning model is better than the increase in student problem-solving abilities provided with the direct learning model.

Besides, based on Table 10, it is found that the Way of Thinking section (B) shows that higher than which means accepted so that it can be concluded that there is no difference in the increase in problem-solving abilities between students who have CS, AS, CR, and AR thinking. If it is seen from the average margin, it is found that the average increase in the problem-solving ability of students who have the SK way of thinking is 46.47, the average increase in problem-solving ability by thinking type SA is 43.89, the average increase in the AK type of thinking is 31.88, and the average increase in type AA thinking was 40.57. The average increase in the way of thinking CS 46.47 is greater than the mean AS 43.89, CR 31.88, and AR way of thinking 40.57 but the difference is not significant as well as the average increase in the AS way of thinking 43.89 is greater than the mean way of thinking. Think CR 31.88 and AR 40.57 but the difference is not significant. Likewise, the mean increase in AA's way of thinking was 40.57 greater than AK's was 31.88, but the difference was also not significant. Furthermore, if seen in the interaction section (AB), it is obtained higher than which means accepted. This means that there is no interaction of increasing student problem-solving abilities between learning models and ways of thinking, so there is no need to continue testing between columns and rows or there is no need for further testing using post-ANOVA.

The results of this study show that rejected so that it can be concluded that the increase in the problem-solving ability of students who are given the PBL learning model is better than the increase in problem-solving abilities taught by the direct model. This happens because, in the PBL learning model, students are required to be able to improve their thinking skills in solving problems both individually and in groups. Following the statement of Tan (2003), the PBL model is an innovation in learning because in the PBL model the thinking ability of students is optimized through a systematic group or teamwork process so that students can empower, hone, test, and sustainably develop their thinking skills. Likewise, Fitriyah (2017) states that in PBL students gain knowledge when solving problems through independent and group learning. Also, in the PBL learning model, students begin with giving problems so that they are required to be able to solve these problems, so students will discuss with their groups in finding solutions to the problems presented which cause students to become accustomed to conducting investigations in finding solutions to these problems because one of the characteristics of PBL learning is conducting independent and group investigations, the lecturer encourages students to collect appropriate information, present experiments, seek explanations and solutions. In the group discussion process, they must be able to solve a given problem by exchanging opinions with one another. Thus, the interaction between students, lecturers, and students in PBL learning both orally and in writing will help them improve and develop problem-solving abilities. But in the direct learning model that the researchers did, students only received what was conveyed by the lecturer and the learning process only occurred in two directions, namely the lecturer and the students so that the problem-solving abilities of students who were taught using the direct learning model were not better than students who were taught using the PBL learning model. This is following the results of Yanti (2017) research that the mathematics problem-solving abilities of students who are taught with the PBL learning model are better than the mathematical problem-solving abilities of students taught with conventional learning. It is also following the results of Susilawati (2019) research which states that PBL can improve problem-solving abilities. Besides, the increase in the problem-solving abilities of students who received the PBL learning model was better than students who received the conventional learning model.

In the analysis test results, it is found that accepted, which means that there is no difference in student problem-solving abilities in terms of the characteristics of the way of thinking. But if seen from the marginal mean, the problem-solving ability of students with the characteristics of the CS way of thinking is greater than the AS way of thinking, the CR way of thinking, and the AR way of thinking as well as the problem-solving abilities of students with the characteristics of the AS way of thinking are greater than the average of the CR way of thinking and AR and students' problem-solving abilities with the characteristics of AR way of thinking are better than CR. This means that there are differences in student problem-solving abilities in terms of the characteristics of the way of thinking, but these differences are not significant. The high marginal mean of students ' problem-solving abilities with CS thinking compared to AS, CR, and AR as well as the high problem-solving abilities of students using SA thinking compared to CR and AR and the high ability of students' problem-solving skills using AR thinking compared to CR. This is because discrete mathematics (MD) courses require more detailed problem solving which must be done step by step. This is following the statement of DePotter and Hernacki (2016) which states that concrete sequential (SK) in solving problems is done by processing information step by step or in detail. In line with research conducted by Lestanti et al. (2016) which states that students with the SK way of thinking in doing questions are carried out step by step in detail and get the correct results on their work. Besides, this MD course also contains problem-solving abilities so that a detailed way of thinking of students will greatly affect students' problem-solving abilities.

4. CONCLUSION

Based on the results of research and discussion, it can be concluded that there is a difference between students' problem-solving abilities through the PBL model and the direct learning model where the problem-solving abilities of students who are given the PBL learning model are better than the increase in problem-solving abilities taught by the direct model. There is no difference in students' problem-solving abilities through the PBL model with the direct learning model in terms of the characteristics of thinking, both concrete sequence (CS), abstract sequence (AS), concrete random (CR), and abstract random (AR).

ACKNOWLEDGEMENTS

Thank you to the Ministry of Research, Technology, and Higher Education for the 2019 Beginner Lecturer Research grant and IKIP PGRI Pontianak as partners in research activities.

REFERENCES

Ambarwati, M. (2016). *Analisis Kemampuan Pemecahan Masalah Dalam Strategi Think Talk Write (TTW)*. *5*(2), 239–246.

Anisa, W. N. (2014). Peningkatan Kemampuan Pemecahan Masalah dan Komunikasi Matematik Melalui Pembelajaran Pendidikan Matematika Realistik untuk Siswa SMP Negeri di Kabupaten Garut. *Jurnal Pendidikan Dan Keguruan Pascasarjana Universitas Terbuka Program*, *1*(1), 133–143. https://doi.org/10.1016/j.bbapap.2013.06.007

Arjudin, Sutawdjaja, A., Irawan, E. B., & Sa'adijah. (2016). Characterization of mathematical conection Errors in Derivative problem solving. *IOSR Journal of Research & Method in Education*, *6*(5), 7–12.

DePotter, B., & Hernacki, M. (2016). *Quantum learning: Unleasing the genius in you (Quantum learning: Membiasakan belajar nyaman dan menyenangkan)*. Kaifa.

Dick, W., & Carey, L. (2005). *The Sistematic Design Of Instruction*. Harper Collins College Publisher.

Fahrudin, D., Mardiyana, & Pramudya, I. (2019). The analysis of mathematic problem solving ability by polya steps on material trigonometric reviewed from self-regulated learning. *Journal of Physics: Conference Series*, *1254*(1), 1–6. https://doi.org/10.1088/1742-6596/1254/1/012076

Fitriyah, S. (2017). The Effectiveness of Problem Based Learning Pop Up Book to the Mathematic Students Ability on Problem Solving Class VIII. *Kontinu: Jurnal Penelitian Didaktik Matematika*, *1*(1), 47–58.

Gunantara, G., Suarjana, M., & Riastini, P. N. (2014). Penerapan Model Pembelajaran Problem Based Learning Untuk Meningkatkan Kemampuan Pemecahahan Masalah Matematis Siswa Kelas V. *Jurnal Mimbar PGSD Universitas Pendidikan Ganesha*, *2*(1), 1–10. https://doi.org/10.15294/kreano.v10i2.19671

Hobri, Ummah, I. K., Yuliati, N., & Daflk. (2020). The effect of jumping task based on creative problem solving on students' problem solving ability. *International Journal of Instruction*, *13*(1), 387–406.

Jensen, A. A., Stentoft, D., & Ravn, O. (2019). *Interdisciplinarity and Problem Based Learning in Higher Education*. Innovation and Change in Professional Education.

Klegeris, A., & Hurren, H. (2011). Impact of problem-based learning in a large classroom setting: Student perception and problem-solving skills. *American Journal of Physiology - Advances in Physiology Education*, *35*(4), 408–415. https://doi.org/10.1152/advan.00046.2011

Lestanti, M. M., Isnarto, & Supriyono. (2016). Analisis Kemampuan Pemecahan Masalah Ditinjau Dari Karakteristik Cara Berpikir Siswa Dlaam Model Problem Based Learning. *Unnes Journal of Mathematics Education.*, *5*(1), 16–23. https://doi.org/10.15294/ujme.v5i1.9343

Mann, L., Chang, R., Chandrasekaran, S., Coddington, A., Daniel, S., Cook, E., Crossin, E., Cosson, B., Turner, J., Mazzurco, A., Dohaney, J., O'Hanlon, T., Pickering, J., Walker, S., Maclean, F., & Smith, T. D. (2020). From problem-based learning to practice-based education: a framework for shaping future engineers. *European Journal of Engineering Education*, *0*(0), 1–21. https://doi.org/10.1080/03043797.2019.1708867

Memnun, D. S., Hart, L. C., & Akkaya, R. (2012). A Research on the Mathematical Problem Solving Beliefs of Mathematics , Science and Elementary Pre-Service Teachers in Turkey in terms of Different Variables. *International of Humanities and Social Science*, *2*(24), 172–184.

Mukasyaf, F., Fauzi, K. M. A., & Mukhtar, M. (2019). Building Learning Trajectory Mathematical Problem Solving Ability in Circle Tangent Topic by Applying Metacognition Approach. *International Education Studies*, *12*(2), 109. https://doi.org/10.5539/ies.v12n2p109

Nugraheni, F., Mastur, Z., & Wijayanti, K. (2014). Keefektifan Model Process Oriented Guided Inquiry Learning Terhadap Kemampuan Pemecahan Masalah. *Unnes Journal of Mathematics Education.*, *3*(1), 1–7. https://doi.org/10.15294/ujme.v3i1.3428

Oguz-unver, A., & Arabacioglu, S. (2011). *Overviews On Inquiry Based And Problem Based Learning Methods*. Western Anatolia Journal of Educational Sciences (WAJES).

Oktaviana, D. (2018). Analisis Tipe Kesalahan Berdasarkan Teori Newman Dalam Menyelesaikan Soal Cerita Pada Mata Kuliah Matematika Diskrit. *Edu Sains: Jurnal Pendidikan Sains & Matematika*, *5*(2), 22–32. https://doi.org/10.23971/eds.v5i2.719

Oktaviana, D., Prihatin, I., & Fahrizar. (2020). Pengembangan Media Pop-Up Book Berbasis Contextual Teaching and Learning dalam Pencapaian Kemampuan Pemecahan Masalah. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *9*(1), 1–11.

Oktaviana, D., & Susiaty, U. D. (2020). Pengembangan Bahan Ajar Matematika Diskrit Dalam Meningkatkan Kemampuan Pemecahan Masalah Matematis Mahasiswa IKIP PGRI Pontianak. *SAP (Susunan Artikel Pendidikan)*, *4*(3). https://doi.org/10.30998/sap.v4i3.6280

Putra, H. D., Thahiram, N. F., Ganiati, M., & Nuryana, D. (2018). Kemampuan Pemecahan Masalah Matematis Siswa SMP pada Materi Bangun Ruang. *Jurnal Ilmiah Pendidikan Matematika*, *6*(2), 82–90.

Rahmadani, N., & Anugraheni, I. (2017). Peningkatan Aktivitas Belajar Matematika Melalui Pendekatan Problem Based Learning Bagi Siswa Kelas 4 Sd. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *7*(3), 241–250. https://doi.org/10.24246/j.scholaria.2017.v7.i3.p241-250

Son, A. L., Sudirman, & Widodo, S. A. (2020). Asosiasi KEmampuan Koneksi dan Pemecahan Masalah Matematika: Cross-Sectional di Timor Barat. *Jurnal Aksioma: Jurnal Program Studi Pendidikan Matematika*, *9*(2), 326–337.

Susanto, E., & Retnawati, H. (2016). Perangkat pembelajaran matematika bercirikan PBL untuk mengembangkan HOTS siswa SMA. *Jurnal Riset Pendidikan Matematika*, *3*(2), 189. https://doi.org/10.21831/jrpm.v3i2.10631

Susilawati, S. (2019). Upaya Meningkatkan Kemampuan Pemecahan Masalah Matematika Dan Kreativitas Siswa Melalui Model Pembelajaran Problem-Bassed Learning Di Sman 2 Bandung. *Pedagogia*, *17*(1), 67–79. https://doi.org/10.17509/pdgia.v17i1.16406

Tambychik, T., & Meerah, T. S. M. (2010). Students' difficulties in mathematics problem-solving: What do they say? *Procedia - Social and Behavioral Sciences*, *8*(5), 142–151. https://doi.org/10.1016/j.sbspro.2010.12.020

Tan, O. (2003). *Problem Based Learning Innovation: Using Problem to Power Learning in 21st Century*. Thompson Learning.

Yanti, A. H. (2017). Penerapan Model Problem Based Learning (PBL) Terhadap Kemampuan Komunikasi dan Kemampuan Pemecahan Masalah Matematika Siswa Sekolah Menengah Pertama Lubuklinggau. *Jurnal Pendidikan Matematika Raflesia*, *2*(2), 118–129.

Yew, E. H. J., & Goh, K. (2016). Problem-Based Learning: An Overview of its Process and Impact on Learning. *Health Professions Education*, *2*(2), 75–79. https://doi.org/10.1016/j.hpe.2016.01.004

Zwaal, W. (2019). Assessment for problem-based learning. *Research in Hospitality Management*, *9*(2), 77–82. https://doi.org/10.1080/22243534.2019.1689696