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The Effectiveness of Accelerated Problem Based Learning With Dynamic Assessment in Achieving Problem-Solving Skills

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Abstract. This research aims to analyzed the effectiveness of Accelerated Problem Based Learning (A-PBL) with dynamic assessment on students' problem-solving skills. This quantitative research had 319 students from the eighth grade of junior high school. The researchers took the sample with a random sampling technique. The results were 32 students for the experimental group. These learners received the A-PBL model with dynamic assessment. The other 32 students for the control group received a direct instruction model. The research instruments were a problem-solving skill test. The data were analyzed by descriptive statistical analysis and then continued with hypothesis testing. The hypothesis tests were independent sample t-test, one-sample t-test, proportional test, and simple linear regression test. The results showed that the A-PBL model is effectively used to achieve problem solving skills with indicators: (1) the learners' mathematic problem-solving skills taught by A-PBL with dynamic assessment met 65 score; (2) the average of learners' mathematics problem-solving skills taught by the A-PBL model and dynamic assessment was higher than the problem-solving skills of learners taught by the direct learning model; and (3) the proportion of students who have completed A-PBL learning with dynamic assessment is more than the proportion of students who have been taught using the direct instruction model. Research contributes scientifically to the development of learning model syntax that can be used to improve problem solving.

Key words: Accelerated; Dynamic Assessment; Problem-solving; Problem Based Learning.

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INTRODUCTION

Mathematics refers to science that could develop cognition, communication, reasoning, and science and technology advancement encouragement for daily lives (Genc & Erbas, 2019; Gooding, 2009; 2019; Muhtadi et al., 2018; Seifi et al., 2012). Mathematic skill is important to develop problem-solving skills. Problem-solving is the core of mathematics learning. It is also the primary part of the targeted learning objectives (Branca, 1980; Gök & Sýlay, 2010; Surya et al., 2017). Problem-solving skill is an integral part of mathematic lesson. Thus, problem-solving skill is important and is inseparable from mathematics learning (NCTM, 1989; Rahayu et al., 2014).

Problem-solving skill is important for learning mathematics. However, many learners still encounter difficulties to be problem-solvers. Learners with difficulties to learning mathematics mostly deal with problem-solving matters, understanding the meaning and information of the problems, feeling confused to process the information, having difficulties to imagine the context, having difficulties to create mathematics model and problems, having difficulties to use accurate method for calculating, having miscalculation, and having difficulties to interpret the questions (Jourbert, 2009).

Learning mathematics needs appropriate and specific learning model to improve the mathematics problem-solving skill and mathematic disposition. Learning model is an influential factor toward learning process (Simbolon & Koeswanti, 2020). One of the problems is applying accurate learning model and assessment to active-based problem-solving learning. Learning with learner-center focus could improve the learners (Wijayanti et al., 2017). The applied learning model is a modification of Accelerated Learning Cycle model, ACL. Problem Based Learning (PBL).

Accelerated Learning Cycle (ALC) model is learning model based on accurate learning experience. Thus, learners will be active and experience meaningful learning. The learning model also allows them to be agile, excited, and feeling comfortable (Kasem et al., 2018). In this research, the researchers combined ALC syntaxes with Problem-based Learning syntaxes.

Problem Based Learning (PBL) is a learning that combines problems and learning processes (Kazemi & Ghoraishi, 2012). A problem-based learning begins with real-life problem scenario to solve (Kim, 2021). The researchers synthesized ALC model syntaxes with PBL model syntaxes into syntaxes of Accelerated Problem based Learning (A-PBL). A-PBL model syntaxes consist of cognitive and affective conditioning, problem orientation, problem-solving organizing, guiding, presenting, integrating, and evaluating. The combination of ALC and PBL into A-PBL aimed to provide an initial stage, cognitive and affective motivation positively for learners. This step allows learners to develop their mathematics disposition before encountering mathematics problems.

The accelerated Problem-based Learning (A-PBL) model combines ALC and PBL to positively motivate students' cognition and emotion. This process allows students to develop their mathematical disposition before encountering mathematics problems. Table 1 presents the applied A-PBL model in this research.

Table 1. Syntaxes of Accelerated Problem Based Learning Model

Syntaxes	Teachers' and Students' Activities
Conditioning	Teachers conditioned both students' cognitions and their feelings before learning. Teachers proposed mathematics problems correlated with other fields in life to solve.
Organizing	Teachers helped students to define and organize problem-solving tasks.
Guiding students' creativity	Teachers guided students creatively to solve problems by collecting relevant information, planning problem-solving strategies, experimenting, and creating explanations and solutions. Students doing Meaningful Math
Presentation	Teachers asked students to present their problem-solving results.
Integrate and evaluate	Teachers helped students to promote self-reflection or evaluation toward problem-solving stages and results.

The integration of A-PBL with dynamic assessment is important to improve problem-solving skill and mathematic disposition. The integration is different with classical assessment that prioritizes learning results. In this integrated dynamic assessment, the integration deals with learning activities (Kartono, 2021). Dynamic assessment orientation does not only deal wit learning result, but learning process. Learning pattern with dynamic assessment consists of three stages. They are teaching, assessing, and teaching stages. The stages last continuously until learners' learning outcome reach the level of actual development zone. Actual development zone is a developmental level in which learners could solve problems without other individuals' assistances.

In dynamic assessment implementation, learners that do not reach actual development zone receives remedial teaching and scaffolding intervention (Shabani et al., 2010). Many scholars studies dynamic assessment implementation without mentioning the applied learning model. They found the learners' learning outcome were improved (Khaghaninejad, 2015).

Dynamic assessment implementation with orientation syntax could develop learners' mathematic disposition with cognitive and affective conditioning stage before learning. Then, in orientation stage, learners train to read, understand, and interpret the problems. After that, in organizing problems, learners connect the mathematics concepts and use various strategies to solve problems. In guiding stage, teachers promote dynamic assessment to evaluate learners' works. If learners commit mistakes, teachers will guide learners by directing them. The next stage deals with presenting the works. This activity can develop learners' confidence. With integration and evaluation stages, learners could develop their reflective thinking as the part of disposition components. Learners also can re-check the process and the latest answers they do so they can ensure the correctness.

This research aims to: 1) analyze the effectiveness of A-PBL learning model modification with dynamic assessment on learners' problem-solving skill achievement, and 2) examine the mathematics disposition effects on learning mathematics toward learners' problem-solving skills.

METHODS

This research is a quantitative study with a posttest only control design by giving a posttest after learning. The research involved 319 eighth graders of Junior High School in Pecangaan, Jepara, Indonesia, from October - November 2021. The researchers used random sampling to take the sample. The results were 32 participants of 8A class as the experimental group. They received the A-PBL model with dynamic assessment. Then, as a control group, the other 32 participants of the 8B class received direct instruction learning with common learning activities at school. The last group was 8C class as the pilot group. At the beginning of the research, the researcher tested the normality, homogeneity, and average variety of the groups to ensure the samples from control and experimental groups had equal skills. Based on SPSS 26's calculation, the results showed the initial skills of experimental, control, and pilot groups were normal and homogeneous. The researcher also did not find differences among the groups. The average skills of the groups were not significantly different. Figure 1 shows the preliminary test result average of each group. Figure 1. The Average of Preliminary Test Result on Mathematics Problem-Solving Skills

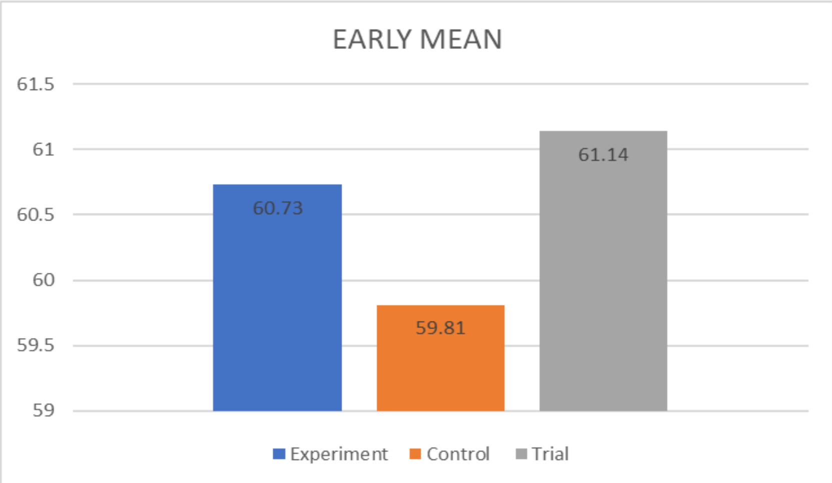

Figure 1. The Average of Preliminary Test Result on Mathematics Problem-Solving Skills

Data Collecting Instruments

The researchers used a written test and a questionnaire as the instruments. The written test was useful to collect data about students' problem-solving skills, while the questionnaire, with a mathematic dispositional scale, was useful to measure students' mathematical disposition. The researchers invited three experts to analyze and validate the instruments with the Aiken V formula. Then, the researcher tested the instruments on the pilot group to find reliability. After analyzing, the researcher found four problem-solving skill question items that were valid with a reliability score of 0.791. These question items were valid and ready to use. The reliability of the mathematic disposition questionnaire was 0.815.

Procedure

This research lasted from October until November 2021. The experimental group received the A-PBL model with dynamic assessment, while the control group received a direct instruction model. Both classes were taught by the same teacher with the same learning instrument. The classes had six mathematics meetings with the straight-line equation. The job of the researcher was to observe and record the learning process. Then, at the end of the research, all participants worked on mathematics problem-solving skill tests. After that, the researcher distributed a mathematical disposition questionnaire for 32 participants of the experimental group.

Data Analysis

In this research, the data distribution was normal. Then, the researchers analyzed the data quantitatively with parametric statistics. The researcher started the analysis with descriptive statistics, including the maximum and minimum scores, mean, and standard deviation. The researcher used an independent sample t-test to compare experimentally and control group students' problem-solving skills. Then, the researcher used a one-sample t-test to test the completion of students' mathematics problem-solving skills toward the minimum standard mastery criterion. A one-party proposition test with simple linear regression was useful to find the influences of mathematical disposition toward mathematics problem-solving skills of students taught by the A-PBL model with dynamic assessment. The researcher used a significant level of 5% and SPSS 26 to calculate.

RESULTS AND DISCUSSION

The average mathematics problem-solving skills of the experimental group is higher than the control group's mathematics problem-solving skill. The experimental group's minimum and maximum scores are also higher than the control group's scores. The calculation results, assisted with SPSS 26, show no significant differences in both groups. Table 2 shows the descriptive statistics data based on the problem-solving question test.

Table 2. Descriptive Statistics

Group	N	Min	Max	Mean	Std. Deviation
A_experimental	32	45.00	100.00	72.6563	12.31210
B_control	32	30.00	90.00	59.0625	15.10381
Valid N (listwise)	32				

The researchers analyzed the problem-solving posttest results to determine the students' mathematics problem-solving skill achievements on each indicator. Table 3 provides the average of mathematics problem-solving skill achievements based on the indicators.

Table 3. The Average of Problem-Solving Skill Test Results

Problem-Solving Skill Indicators	Experimental group	Control group
Establishing new mathematical knowledge through problem-solving	8.825	7.575
Solving problems that arise in mathematics and other contexts	6.275	4.755
Applying and adapting a variety of appropriate strategies to solve problems	5.635	5.025
Monitoring and reflecting the process of mathematical problem solving	8.325	6.315

Table 3 shows the achievements of each mathematics problem-solving indicator of the experimental group taught by the A-PBL model with DA are higher than the control group, taught by the direct instruction model. The highest difference is visible in solving problems that arise in mathematics and other contexts. Then, there is no difference in monitoring and reflecting the process of mathematical problem-solving.

Table 3 shows the differences between the experimental group's mathematics problem-solving skills and the control group's based on each indicator. They are 12.5%, 15.2%, 6.1%, and 2.01%. The second-highest difference is visible in solving problems that arise in mathematics and other contexts. The difference based on the indicator achievement between experimental and control groups is 15.2%. It happened because control group students did not understand the presented contextual problems. Thus, they could not solve it accurately. The lowest difference is 2.01%, found in monitoring and reflecting the process of mathematical problem-solving. It happened because experimental and control groups' students could not re-check their problem-solving process. They also could attempt to use different solutions.

The sample is relatively small, so the normality test used the Shapiro-Wilk test. The normal distribution of problem-solving-skill posttest results with a p-value of 0.232 > 0.05. Thus, the researcher used a statistic parametric hypothesis test of learning completion.

The first hypothesis test is a one-sample average test. The proposed hypothesis is

H_0 : the average score of students' problem-solving skills taught by A-PBL with DA is less than or equal to 65

H_a : the average score of learners' problem-solving skills taught by A-PBL with DA is higher than 65

The difference test for the right tail average and the statistic t-test was useful to determine the first hypothesis.

Tabel 4. One Sample Average Test Results

One-Sample Test						
	Test Value = 65					
					95% Confidence Interval of the Difference	
	t	df	Sig. (2-tailed)	Mean Difference	Lower	Upper
Exp	3.518	31	.001	7.65625	3.2173	12.0952

The result of SPSS 26 shows t_{count} = 3.518. The $_{table}$ is 1.6955 at the significant level of 5% and df (32) = 31. Thus, $t_{count} > t_{table}$ so that H_0 is denied. From the calculation, the experimental group students' problem-solving skills were higher than 65.

Table 4 shows the experimental and control group's problem-solving skills are normally distributed. The calculation results from SPSS 26 also show both groups' variants are not significantly different. From the results, the researchers used parametric statistics to test hypothesis 2 and hypothesis 3.

Hypothesis 2 deals with the average difference test for both parties' one-tailed independent sample tests. The proposed hypothesis is

H_0 : the average of students' problem-solving skills taught by A-PBL with DA is less or equal to those taught by the direct instruction model.

H_a : the average of learners' problem-solving skills taught by A-PBL with DA is higher than those taught by direct instruction model.

T-test statistics are used to calculate hypothesis 2. The calculations with the help of SPSS 26 are listed in Table 5.

Table 5. Two-Sample Average Test Results

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
score	Equal variances assumed	1.819	.182	3.946	62	.000	13.59375	3.44471	6.70787	20.47963
	Equal variances not assumed			3.946	59.579	.000	13.59375	3.44471	6.70230	20.48520

The result of SPSS 26 shows t_{count} = 3.946. The $_{table}$ is 1.6698 at the significant level of 5% and df ((32+32)-2)) = 62. Thus, $t_{count} > t_{table}$ so that H_0 is denied. From the results, the average of students' problem-solving skills taught by A-PBL with DA is higher than those taught by the direct instruction model.

Hypothesis 3 deals with the proportion difference test for both parties' one-tailed independent sample tests. The proposed hypothesis is:

H_0 : the proportion of students achieving 65 in A-PBL with DA is lesser than or equal to students' proposition taught by direct instruction.

H_a : the proportion of learners achieving 65, in A-PBL with DA, is higher than learners' proposition taught by direct instruction.

The researcher tested the third hypothesis with Z-test. The z_{table} is 1.645 at a significant level of 5%. Thus, $z_{count} > z_{table}$ so that H_0 is denied. From the result, the proportion of students achieving 65 in A-PBL with DA is higher than students' proposition taught by direct instruction.

Discussion

The findings showed the average of learners' mathematics problem-solving skills taught by A-PBL with dynamic assessment could reach the minimum standard mastery, 65. Problem-based learning could facilitate learners to reach the minimum standard mastery. A-PBL model focuses on learners' activities to solve mathematics problems by reviewing the problems and developing the solutions. PBL allows learners to develop their self-learning directedness and self-complex skills (Sugiharto et al., 2019). Each problem-based learning syntax influenced learners' problem-solving skill achievements (Cheriani et al., 2015).

A-PBL stages emphasize on active learning. The PBL implementation in experimental group made the learners more active and motivated to solve problems than control group (Argaw et al., 2017). The increased learners' activeness also helped them to develop thinking skills in solving problems (Balim et al., 2014; Saputra et al., 2018). A-PBL required learners to take their roles in group works. They were enthusiastic to participate because they had roles to do in the classroom (Kartono & Shora, 2020; Suarsana et al., 2019).

The learning was continued by providing other problems related to other fields in real life. In this research, the problems dealt with science, trading, sport, and health. With contextual mathematics question items from various life fields, learners realized the roles of mathematics to facilitate human life. The implications were they believed the uses of mathematics and learned it persistently and successfully. In this case, they were aware to bring mathematics in other fields of life. Mathematics lesson with relevant real-life problems could improve the learners' mathematics skills (Rahayu et al., 2019; Ulya & Rahayu, 2021)

In the organizing stage, the teacher taught the learners to solve problems. The teacher gave worksheet as the guideline to solve the given question exercises. Learners could improve their mathematics skills due to worksheet assistance (Riwayati & Destania, 2018). Problem-based oriented activities facilitated learners to develop their skills in understanding, finding solution, solving problems, and reflecting the processes (Downing et al., 2009). In PBL, the first stage is -bringing the problems. Then, the stage allows learners to understand the problems (English, 1997; Sari et al., 2021).

The applied assessment for experimental group was dynamic assessment. The assessment did not only cover the lesson, but also the learning process to determine the learners' problem-solving skill achievements. Each syntax of A-PBL provided learners some stages. If the learners committed mistakes in solving problems, teacher could guide them. This follow-up allowed learners to obtain feedback and improve their working stages. Dynamic assessment is a method to diagnose and develop cognitive functions of learners (potency to develop) by providing instruction during the assessment to evaluate learners' responses (Vygotsky, 1986). Dynamic assessment implementation in learning could improve learners' learning outcomes (Khaghaninejad, 2015).

In the last syntax of A-PBL, the integration and evaluation, learners re-checked all problem-solving processes. This syntax aimed to reflect all promoted activities by the learners. Thus, they could learn meaningfully. Problem solving is also a part of higher-order thinking skill (Carter et al., 2017). This skill develops the analysis technique and decision-making process based on group or individual analyses. Learners analyzed the phenomena and expressed them with evidence and argument so they could obtain solution. The investigating process of PBL develops learners' skills to manage information and the learners' background knowledge (Belland et al., 2010; Suntusia & Hobri, 2019).

CONCLUSION

The results and discussion proved A-PBL with dynamic assessment effectively improved students' problem-solving skills by meeting several criteria. They were (1) the average of mathematics problem-solving skills of students taught by A-PBL with dynamic assessment was higher than 65; (2) the average of mathematics problem-solving skills of students taught by A-PBL with dynamic assessment was higher than those taught by direct instruction, and (3) the proposition of students taught by A-PBL with DA reached 65, higher than the proposition of control group taught by direct instruction. This research recommends future researchers: (1) compare the problem-solving skill data and mathematical disposition data before and after the intervention of A-PBL with dynamic assessment. This comparison is useful for analyzing the increased gain or improvement; (2) the number of classroom meetings should be added so students can habituate themselves with questions and mathematics problem-solving skill stages.

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