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THE PROFILE OF STUDENTS' MATHEMATICAL REPRESENTATION COMPETENCE, SELF-CONFIDENCE, AND HABITS OF MIND THROUGH PROBLEM-BASED LEARNING MODELS

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ABSTRACT

Mathematics is an essential subject for students. Teachers, therefore, need to provide innovative learning that develops students' mathematical skills. This study was conducted to determine the effect of a problem-based learning (PBL) model on students' mathematical representation competencies, self-confidence, and habits of mind. It used a quantitative methodology and was conducted on eighth-grade students divided into an experimental class with a PBL model and a control class with a direct learning model. The results showed that the mathematical representation competencies of the students in the experimental class were better than those in the control class. Students' self-confidence and habits of mind also influenced their mathematical representation competencies. It shows that the PBL model positively affects students' mathematical representation competency, self-confidence, and habits of mind. Teachers can use the PBL model to develop their students' mathematical representation competencies by paying attention to students' self-confidence and habits of mind.

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1. INTRODUCTION

Mathematics is a subject that is part of the curriculum from elementary school through higher education. In schools, it is very important to be taught as a provision for students to solve their problems in everyday life or to continue in higher education. Students are stimulated in their learning to understand mathematical concepts by solving various problems in the context of mathematical material (Atiyah & Nuraeni, 2022; Hidayat & Husnussalam, 2019; Lidinillah et al., 2022). Teachers at school should pay close attention to classroom learning activities so that students can maximize their abilities and properly achieve the learning goals of mathematics, one of which is to develop all of their potential throughout the educational process (Hidayat et al., 2022; Hutajulu et al., 2019).

Mathematical representation is one of the important competencies in learning mathematics. Good representation competency can help students to represent notations, symbols, graphs and other representations in mathematics (Lestari et al., 2020; Muhtarom et al., 2019). All of this will clearly help students when they solve problems. One of the goals of representation competency is to train students' problem-solving skills (Widya & Manoy, 2022). At the school level, there are still many obstacles to optimizing mathematical representation competency. One of the obstacles is that students have difficulty understanding word problems because they still lack the mathematical knowledge to solve the problems, which results in difficulty representing the right symbols (Verschaffel et al., 2020).

In mathematics, mathematical representations are essential because they allow students to clarify and extend their understanding of complex mathematical concepts. By using the right mathematical representations, mathematical concepts can be expressed and analyzed more effectively and efficiently, and deeper insights into the underlying mathematical structures can be gained. These mathematical representations also enable the creation of solution plans and the application of necessary mathematical operations (Boonen et al., 2016; Prahmana et al., 2020). Mathematical representation is a way of expressing mathematical ideas or concepts using symbols, pictures, or other forms that are easy to understand and learn. It plays an important role in facilitating mathematics teaching and learning by helping students to understand abstract and difficult mathematical concepts more easily. In this context, students' competency to use mathematical representations to solve problems is influenced by their level of mathematical ability (Lette & Manoy, 2019).

Mathematical representation is the result of the interpretation of thoughts in the form of expressions of mathematical ideas by students that are presented, or can also be referred to as a substitute form of a problem that is faced by students (Hartono et al., 2019). It is an expression to convey students' algebraic thinking and to construct their ideas about patterns and functions (Awaludin et al., 2021).

In addition, mathematical representation is a way of presenting mathematical concepts in certain symbols or notations that allow clarification and expansion of understanding of certain mathematical topics. The process of mathematical representation can be said to be the transformation or conversion of a problem model into a new form (Herdiman et al., 2018). Mathematical representations can take the form of graphs, tables, diagrams, formulas, and more. There are five representations in mathematics: contextual representation, concrete representation, arithmetic symbolic representation, verbal representation, and visual or graphical representation (Awaludin et al., 2021; Ratnasari et al., 2018). Representation includes visual models or manipulative and visual materials (Jitendra et al., 2016).

Students' mathematical representation competency is also influenced by their habits of mind and self-confidence. The habits of mind and self-confidence that emerge from the learning activities help them put their ideas into action to produce better solutions. Habits of mind are seen as a continuous and never-ending process in which a person is constantly trying to improve their thinking skills. It involves the development of skills such as problem solving, critical thinking, communicating, and working with others. Having mathematical habits of mind is crucial for students and therefore this soft skill needs to be trained and developed from the time of their primary education (Nisa et al., 2020). Habits of mind play an important role in the learning process and individual development by helping to solve problems (Miliyawati, 2014).

Habits of mind are the habits of thinking flexibly, managing impulsivity, listening with empathy, asking questions, and solving problems effectively (Diva & Purwaningrum, 2023), applying past knowledge to new situations, establishing communication, thinking clearly with precision, using all senses to gather information, trying different ways and generating new ideas, responding, taking responsibile risks, having a sense of humor, thinking interactively with others, being open-minded, and being open to continuous learning (Desti et al., 2020; Miliyawati, 2014). It is a systematic and consistent way of thinking that can help one to solve problems, make the right decisions, and meet the challenges of everyday life.

Further, habits of mind are tendencies and habits of thinking intellectually and intelligently to find solutions to problems that are not yet known. Millman and Jacobbe (Miliyawati, 2014) identified several mathematical habits of mind: exploring mathematical ideas, reflecting on the correctness of answers, identifying problem-solving strategies that can be applied to solve problems on a broader scale, asking oneself if there is “something more” and mathematical activities that have been done (generalization), formulating questions, constructing examples of mathematical activities that have been done.

Habit of mind refers to a consistent mental attitude in dealing with certain situations. This includes being able to face challenges with determination, work collaboratively, and adapt to change. Students who have a strong habit of mind tend to have the ability to focus, organize, and control their learning process. This allows students to develop deeper understanding, relate new information to existing knowledge, and make broader connections between various concepts. Thus, a strong habit of mind can influence students' ability to represent information in a more comprehensive and organized manner.

Like habits of mind, self-confidence is no less important. Self-confidence is essential for students to achieve academic success. It is a basic asset that students must have (Adharini & Herman, 2020), because students with high self-confidence tend to be more motivated to learn and have the ability to face learning challenges. Conversely, students who have low self-confidence may have difficulty with learning and may be at risk of failure. Self-confidence is not something one is born with or without. It is something that can be learned and developed throughout life. There are several factors that can influence the level of self-confidence, including personal experiences, experiences of others, verbal persuasion, and physiological responses. As one of the human psychological behaviors, self-confidence has an important influence on decision making (Liu et al., 2019).

Self-confidence is the confidence an individual has in their abilities, talents, and potential. People have beliefs that can be seen in their behavior or emotions. The human brain has an extraordinary control system. A well-trained brain has many effects on one's life and the lives of others, including increasing confidence in one's abilities, thinking and acting positively in the face of problems, displaying optimism and calmness, and being resilient, adaptable, and sociable (Adharini & Herman, 2020).

Self-confidence can also be defined as the belief in one's ability to perform an action or overcome a problem. It includes positive mental attitudes such as the ability to make the right decisions and the ability to cope with challenges and failures (Hendriana et al., 2018). Indicators of self-confidence include believing in one's own abilities, making decisions independently, having a positive self-concept, and daring to express opinions (Ulfa et al., 2021).

Self-confidence also plays an important role in student representation. Confident students tend to have higher confidence in their ability to face learning challenges. They have confidence that they can overcome any difficulties they may face. High self-confidence helps students to build a good perception of their abilities and motivates them to try harder.

Confidence can help overcome their anxiety in expressing students' understanding orally or in writing. This allows them to communicate their ideas more clearly and effectively.

The students' habits of mind and self-confidence play a role in influencing student representation. A strong habit of mind helps students build an orderly and consistent mindset in learning mathematics, while self-confidence gives students confidence in conveying and expressing their understanding of the mathematical concepts they understand. Both of these support students in developing better representations in learning mathematics.

A learning model serves to guide teachers in designing learning and is used as a reference for implementing learning that aims to achieve effective, efficient, and highly student-centered learning (Hartati et al., 2020; Hendriana et al., 2022; Hidayat et al., 2023). The problem-based learning model is a learning model with a scientific approach in which the learning process is learner-centered (Septianto et al., 2019). This learning model requires students to solve a problem given by the teacher while the teacher guides them to understand the given problem through problem orientation activities. The teacher organizes students into groups to discuss and find solutions. Students are required not only to find a solution, but also to present the solution to the class and evaluate it with friends from other groups. The steps of problem-based learning (PBL) as an independent activity include orienting students to a problem, dividing students into small groups to discuss the problem and find solutions, providing enhancement by the teacher, and drawing conclusions by the students (Erlina & Purnomo, 2020; Maulidia et al., 2019; Zetriuslita & Ariawan, 2021). More specifically, PBL consists of five stages: orienting students to problems, organizing students to learn, supporting independent and group inquiry, developing and presenting work and exhibiting it, analyzing and evaluating the problem-solving process (Shofiyah & Wulandari, 2018).

Based on the background of the problem, the purpose of this study was to determine the effect of a problem-based learning (PBL) model on students' representation skills, self-confidence, and habits of mind. Mathematical representations often involve the use of pictures, diagrams, or graphs. It helps us to visualize math concepts and develop visual thinking habits. The ability to visually represent math problems allows us to see patterns, relationships, and solutions that are not visible in symbolic form. The problem-based learning model is one of the innovative learning models. It is a learning model that trains students to solve problems through discussion activities and to present the results to the class, and it is at the forefront of the many approaches used to teach problem-solving skills (Aslan, 2021).

2. METHOD

This study used a quantitative methodology. In this study, students in the eighth grade of the same junior high school were divided into two classes: an experimental class and a control class (see Table 1). The selection of these classes by means of cluster random sampling. The experimental class used the problem-based learning model, while the control class used the direct learning model.

Table 1. Subject of the study

Description	Experimental	Control
Class	8-G	8-H
Number of Students	29	33

The Mathematical Representation ability test, Self Confidence Questionnaire, and student Habit of mind questionnaire (see Table 2) were adopted from Utari Sumarmo's book (Sumarmo et al., 2019). Data on students' mathematical representation competencies were analyzed using t-test to compare experimental and control classes. The next analysis used regression to see the effect of self-confidence on representation competency and the effect of habits of mind on students' mathematical representation competencies. Regression analysis was carried out in the experimental class with PBL. This analysis was conducted to see the influence of students' self-confidence on students' mathematical representation abilities and the influence of students' thinking habits on students' representation abilities in learning with PBL. The PBL model was declared to have an effect on students' representation competencies, self-confidence, and habits of mind if the mathematical representation competencies of the students in the experimental class were better than those in the control class, if there was an effect of self-confidence on students' mathematical representation competencies, and if there was an effect of habits of mind on students' mathematical representation competencies. Statistical tests were performed using SPSS.

Table 2. Research instruments

Data	Data Collection Method
Representation competency	Test
Self-confidence	Questionnaire
Habits of mind	Questionnaire

3. RESULT AND DISCUSSION

3.1. Results

The learning in the experimental class used the PBL model, and the learning in the control class used the direct learning model. The results of the test on students' mathematical representation competencies, self-confidence, and habits of mind are as follows.

Table 3. Mean results of the test and questionnaire

Class	Aspect		
	Representation Competency	Self-Confidence	Habits of Mind
Experimental	31.97	97.72	108.55
Control	26.15	88.70	99.15

Table 3 shows the score of the mathematical representation test, the score of the self-confident questionnaire results, and the habit of mind of students in the experimental class is greater than that of the control class. Learning through PBL model and direct learning model was well implemented. Teacher activities and student activities in the classroom were conducive. Both classes were assumed to be homogeneous. The results of the t-test comparing the experimental class with the control class are displayed in Table 4.

Table 4. Independent samples test

		Levene's Test for Equality of Variances		t-test for Equality of Means						
		F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	95% Confidence Interval of the Difference	
									Lower	Upper
Representation	Equal variances assumed	40.833	0.000	4.501	56	0.000	5.379	1.195	2.985	7.774
	Equal variances not assumed			4.501	35.248	0.000	5.379	1.195	2.953	7.805

Table 4 show that with equal variances assumed in the sig. (2-tailed) column, sig.=0.000 < 5% and therefore H_0 is rejected. Thus, the mean representation competency of the experimental class was different from that of the control class. The group statistics table shows that the mean of the experimental class was 31.97 better than that of the control class. In other words, the representation competency of the experimental class was better than that of the control class.

The next test is the regression test to determine the effect of students' self-confidence on students' mathematical representation in classes with the PBL model. The prerequisite test is carried out for the feasibility of the linear regression model that will be obtained. The tests carried out were the normality test with the Kolmogorov-Smirnov test (see Table 5), and the linearity test (see Table 6).

Table 5. One-sample kolmogorov-smirnov test

		Unstandardized Residual
N		29
Normal Parameters[a,b]	Mean	0E-7
	Std. Deviation	0.55170152
Most Extreme Differences	Absolute	0.069
	Positive	0.069
	Negative	-0.053
Kolmogorov-Smirnov Z		0.373
Asymp. Sig. (2-tailed)		0.999

a. Test distribution is Normal.

b. Calculated from data.

Table 5 show that the significance value of Asiymp.Sig. (2-tailed) is 0.999 greater than 0.05, it can be concluded that the data is normally distributed. Thus, the assumption of normality requirements in the regression model between the self-confident variable (X_1) and the mathematical representation variable (Y) has been fulfilled.

Table 6. ANOVA on self-confidence and mathematical representation ability

			Sum of Squares	df	Mean Square	F	Sig.
Representation * Self-Confident	Between Groups	(Combined)	133.299	22	6.059	21.813	0.000
		Linearity	126.443	1	126.443	455.195	0.000
		Deviation from Linearity	6.856	21	0.326	1.175	0.454
	Within Groups		1.667	6	0.278		
	Total		134.966	28			

The Deviation from Linearity Sig value is 0.454, more than 0.05 (see Table 6). So it can be concluded that there is linear relationship between the self-confidence variable (X) and the mathematical representation variable (Y).

In addition to the influence of students' self-confidence, the effectiveness of learning with PBL models was also assessed by the influence of habits of mind (X_2) on students' mathematical representation competencies (Y). Regression tests were also carried out to determine the effect of students' habit of mind on students' mathematical representation in classes using the PBL model. Before the regression test is carried out, the prerequisite test is also carried out for the feasibility of the linear regression model to be obtained. The tests carried out were the normality test with the Kolmogorov-Smirnov test (see Table 7), and the linearity test (see Table 8).

Table 7. One-sample kolmogorov-smirnov test

		Unstandardized Residual
N		29
Normal Parameters[a,b]	Mean	0E-7
	Std. Deviation	0.58624296
Most Extreme Differences	Absolute	0.138
	Positive	0.138
	Negative	-0.127
Kolmogorov-Smirnov Z		0.741
Asymp. Sig. (2-tailed)		0.643

a. Test distribution is Normal.
b. Calculated from data.

Table 7 show that the significance value of Asiymp.Sig. (2-tailed) is 0.643 greater than 0.05, it can be concluded that the data is normally distributed. Thus, the assumption of normality requirements in the regression model between the habit of mind variable (X_2) and the mathematical representation variable (Y) has been fulfilled.

Table 8. ANOVA on habit of mind and mathematical representation ability

			Sum of Squares	**df**	**Mean Square**	**F**	**Sig.**
Representation * Habit of Mind	Between Groups	(Combined)	133.132	18	7.396	40.343	0.000
		Linearity	125.342	1	125.342	683.686	0.000
		Deviation from Linearity	7.790	17	0.458	2.499	0.072
	Within Groups		1.833	10	0.183		
	Total		134.966	28			

The Deviation from Linearity Sig value is obtained. is 0.458 more than 0.05 (see Table 8). So it can be concluded that there is a significant linear relationship between the Habit of Mind variable (X_2) and the mathematical representation variable (Y).

The next prerequisite test, namely the heteroscedasticity test, was carried out to find out whether in a regression model there is an inconvenience variant of the residuals in one observation against other observations.

Table 9. Coefficients[a] on self-confidence and habit of mind

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	-1.554E-015	0.993		0.000	1.000
	Self-Confident (X_1)	0.000	0.021	0.000	0.000	1.000
	Habit of Mind (X_2)	0.000	0.025	0.000	0.000	1.000

a. Dependent Variable: Abs_RES

Table 9 shows that the significance value (Sig.) for the Self-Confident variable (X_1) is 1.00, and the Habit of mind variable (X_2) is 1.00, so according to the glacier test it can be concluded that there are no symptoms of heteroscedasticity in regression models. Furthermore, The effect of learning in the experimental class using PBL was evaluated by studying the effect of self-confidence on students' mathematical representation competencies. The results of the regression test to verify the effect of self-confidence (X_1) on students' mathematical representation competencies (Y) are shown in the Tables 10 to 12.

Table 10. Self-confidence model summary

Model	R	R-Squared	Adjusted R-Squared	Std. Error of the Estimate
1	0.332[a]	0.110	0.077	2.10892

a. Predictors: (Constant), Self_Confidence

Table 11. ANOVA[b] on self-confidence and representation

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	14.882	1	14.882	3.346	0.078[a]
	Residual	120.084	27	4.448		
	Total	134.966	28			

a. Predictors: (Constant), Self_Confidence

b. Dependent Variable: Representation

Table 12. Coefficients[a] of self-confidence

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	27.285	2.588		10.541	0.000
	Self_Confidence	0.048	0.026	0.332	1.829	0.078

a. Dependent Variable: Representation

Table 10 shows that R, which is the correlation coefficient, was 0.332. This coefficient value can be interpreted that the correlation between the two research variables was weak. Table 10 also displays the R-squared or coefficient of determination, which indicates how well the regression model formed by the interaction of the independent variable and the dependent variable is performing. The coefficient of determination obtained was 11%, which can be interpreted to mean that the independent variable X_1 (students' self-confidence) had a contributing influence of 11% on the variable Y (students' mathematical representation competencies), while the remaining 89% was influenced by other factors other than the variable X_1.

ANOVA was used to determine the level of significance or linearity of the regression and the results are presented in Table 11. The criteria can be determined based on the F-test or the significance (Sig.) test. The simplest way is the significance test, provided that if the value of Sig.<0.05, then the regression model is linear, and vice versa.

Based on Table 12, the Sig. value was 0.078, which was greater than the criterion of significance (0.05), so the regression equation model based on the research data was not significant. Further, Table 12 shows the regression equation model obtained with the constant coefficient and variable coefficient in column B under the Unstandardized Coefficients column. Based on this table, the regression equation model is obtained as follows: $Y = 27.285 + 0.048 X_1$. However, in the prerequisite test it was concluded that the linear model formed could show that there is a linear relationship between the self-confident variable (X_1) and the mathematical representation variable (Y). this shows a positive influence but not that big.

The next analysis is the regression test for the habit of mind variable (X_2) with students' mathematical representation (Y). The results of the regression analysis of the habit of mind variable with a mathematical representation are shown in the following Tables 13 to 15.

Table 13. Habits of mind model summary

Model	R	R-Squared	Adjusted R-Squared	Std. Error of the Estimate
1	0.398[a]	0.159	0.128	2.05070

a. Predictors: (Constant), Habtis_of_Mind

Table 14. ANOVA[b] on habits of mind and representation

Model		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	21.420	1	21.420	5.094	0.032[a]
	Residual	113.545	27	4.205		
	Total	134.966	28			

a. Predictors: (Constant), Habits_of_Mind

b. Dependent Variable: Representation

Table 15. Coefficients[a] of habits of mind

Model		Unstandardized Coefficients		Standardized Coefficients	t	Sig.
		B	Std. Error	Beta		
1	(Constant)	24.381	3.382		7.208	0.000
	Habits_of_Mind	0.070	0.031	0.398	2.257	0.032

a. Dependent Variable: Representation

Table 13 shows that R, which is the correlation coefficient, was 0.398, and therefore it can be interpreted that the correlation between the two research variables was weak. The R-squared value or the coefficient of determination, which shows how good the regression model formed by the interaction of the independent variable and the dependent variable is performing, was also obtained. The coefficient of determination obtained in this study was

39.8%, which indicates that the independent variable X_2 had a contributing influence of 39.8% on the variable Y, and the other 60.2% was influenced by other factors outside the variable X_2.

ANOVA was used to determine the level of significance or linearity of the regression and the results are presented in Table 14. The criteria can be determined based on the F-test or the significance (Sig.) test. The simplest way is the significance test, provided that if the value of Sig.<0.05, then the regression model is linear, and vice versa. Based on Table 14, the Sig. value was 0.032, which was less than the criterion of significance (0.05), so the regression equation model based on the research data was significant, or in other words, the linear regression model met the linearity criterion.

Table 15 shows the regression equation model obtained with the constant coefficient and variable coefficient in column B under the Unstandardized Coefficients column. Based on this table, the regression equation model is obtained as follows: $Y = 24.381 + 0.070 X_2$.

Students' mathematical representation competencies in the experimental class that used PBL model were better than those in the control class that used the direct learning model. In addition, students' self-confidence and habits of mind also influenced students' mathematical representation competencies. The results showed that PBL model had an effect on students' mathematical representation ability, self-confidence, and habits of mind.

3.2. Discussion

In this study, problem-based learning (PBL) had a positive effect on learning. This result indicates that learning with PBL model has a good effect on students. Learning with PBL resulted in the mathematical representation competencies of students in the experimental class being better than those of students in the control class using direct learning. Students' activities in the classroom had trained students to understand and discuss problems to solve them.

In the discussion process that students engage in during problem-based learning, students' knowledge, attitudes, and problem-solving skills are really needed to determine solutions. The activity of communicating ideas and finding solutions trains students to help each other. Students who do not perform well in learning activities are helped by students who do. Students also gain confidence. A good level of self-confidence enables students to learn easily, because people with a lower level of self-confidence in math tend to have a higher level of anxiety (Di Lonardo Burr & LeFevre, 2020). Teachers using PBL model act as facilitators. Students gain new knowledge through the problem-solving process. Students' understanding of mathematical concepts can be improved by teachers reviewing students' initial knowledge and understanding before introducing new concepts (Wakhata et al., 2023). Teacher guidance and student collaboration make learning more lively and enthusiastic.

The learning process with PBL raises students' habits of mind and self-confidence. This was raised through discussion and collaboration activities during group discussions and presenting the results of their discussions in class. The group discussion process trains them to connect the knowledge they have with the new knowledge they get in class. Students will be familiar with the question and answer process either with the teacher or with other students. Openness with other people's opinions in finding solutions to problems given by the teacher leads students to have a variety of variations and innovative representations. Habits like this train students to keep trying and not give up easily to have a better ability to represent mathematical problems visually or symbolically. The ability to adapt and remain firm in difficult situations affects the habit of mind of students (Kurniansyah et al., 2022; Maarif & Fitriani, 2023; Zetriuslita et al., 2020).

Activities in PBL also help students have good self-confidence. Mental activity to build ideas / ideas in dealing with problems can increase self-confidence (Hendriana et al., 2018). Students who believe that they have the ability to understand and solve mathematical problems will tend to have stronger self-confidence in representing mathematical concepts. This can be seen during the activity of presenting the results of group discussions at one of the PBL steps. Students who have strong self-confidence will continue to believe in their abilities even though there are errors in the results of their group discussions. They see mistakes as an opportunity to learn and improve their mathematical representations when presenting the results of their discussions in class. students' learning potential will develop if it is supported by self-confidence (Yaniawati et al., 2020).

Thus, all the explanations presented here confirm the importance of mathematical representation competency in learning mathematics, because it helps students understand and master mathematical concepts more easily and effectively. Good and adequate mathematical representation competency can help students to strengthen their logical, analytical and creative thinking skills and increase their motivation and interest in learning mathematics. Students with high competencies will be able to meet the indicators of mathematical representation (Saputri & Izzati, 2023).

Using mathematical representations in a variety of ways can help improve students' understanding of mathematical concepts. Mathematical representation is the basic ability to construct mathematical concepts and reasoning used to solve a problem (Hidayat et al., 2022; Nurbayan & Basuki, 2022). Different mathematical representations, such as graphs, tables, or diagrams, can help students visualize mathematical concepts and relationships in different ways. Mathematical representation competency can be a means of understanding mathematical concepts, because it can help to develop real problems from everyday life and to present them in a mathematical language (Annisa, 2022). For this reason, mathematics teachers need to be familiar with good and effective techniques for teaching mathematical representations to their students.

The development of effective thinking skills can be achieved through a variety of learning methods and approaches, including direct instruction, hands-on experience, collaboration, and reflection (Harisman et al., 2020). In addition, it is important for teachers to provide positive feedback and support to students so that they can continue to improve their thinking skills. Teachers can provide students with positive experiences to help them develop confidence (Ahmad et al., 2021; Nasution et al., 2021). Positive experiences can be in the form of success in learning or in other school activities. In fact, one factor that influences mathematical representation competency is the experience of learning (Harisman et al., 2021; Hendriana et al., 2018). In addition, teachers can effectively provide students with positive and constructive feedback on their academic skills and performance, helping to build their confidence and encouraging them to develop a deeper understanding of a concept.

4. CONCLUSION

Based on the previously presented results and discussion, PBL model has an effect on students' mathematical representation competencies, self-confidence, and habits of mind. This is indicated by the fact that the mathematical representation competencies of the students in the class using PBL model were better than those of the students in the class using direct learning model. Students' self-confidence influences their mathematical representation competencies, as do their habits of mind. Problem-based learning model can be a good alternative in implementing innovative learning. Teachers or other researchers who focus on students' representation competencies, self-confidence, and habits of mind can use this learning model.

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