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Students' Mathematical Problem Solving Ability With Introduction, Connection, Application, Reflection, and Extension Models

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Kata Kunci
Model ICARE, Pemecahan Masalah Matematis

ABSTRAK

Kemampuan pemecahan masalah matematis salah satu yang harus dikembangkan selama proses pembelajaran matematika, dapat dikembangkan melalui penerapan model pembelajaran ICARE. Tujuan artikel untuk mengetahui kemampuan pemecahan masalah matematis peserta didik kelas IX SMP Negeri 5 Padang yang pembelajarannya menerapkan model pembelajaran ICARE lebih tinggi daripada pembelajaran saintifik. Jenis penelitian *Quasi Experiment* dengan rancangan *Randomized Control Group Only Design*. Populasinya peserta didik kelas IX SMP Negeri 5 Padang, sampel kelas IX.7 sebagai kelas eksperimen 31 orang dan kelas IX.3 sebagai kelas kontrol 32 orang. Uji-t digunakan untuk menganalisis data. Berdasarkan tes, nilai rata-rata tes kemampuan pemecahan masalah matematis kelas eksperimen adalah 79,23 sedangkan kelas kontrol 68,87. Uji-t juga menunjukkan bahwa $t_{hitung} > t_{tabel}$ yaitu $(3{,}16) > (1{,}99)$ maka keputusannya adalah hipotesis diterima, kesimpulannya model ICARE dapat meningkatkan kemampuan pemecahan masalah matematis peserta didik kelas IX SMP Negeri 5 Padang.

Model ICARE, Mathematical Problem Solving

One of the mathematical problem-solving abilities that must be developed during the mathematics learning process can be developed through the application of the ICARE learning model. The purpose of the article is to find out the mathematical problem-solving abilities of class IX students of SMP Negeri 5 Padang whose learning applies the ICARE learning model higher than scientific learning. Quasi Experiment with research type with a randomized control group only design. The population is class IX students of SMP Negeri 5 Padang; a sample of class IX.7 as an experimental class is 31 people, and class IX.3 is a control class with 32 people.The t-test was used to analyze the data. Based on the tests, the average score of the experimental class mathematical problem-solving ability test was 79.23*, while that of the control class was* 68.87*. The t-test also shows that* $t_{count} > t_{table}$ *is* $(3.16) > (1.99)$*, so the decision is that the hypothesis is accepted. In conclusion, the ICARE model can improve* *the mathematical problem-solving abilities of class IX students at SMP Negeri 5 Padang.*

INTRODUCTION

Science is very important in this life. Due to its development, humans have made progress in civilization. Humans have created something that was never imagined possible for them. The importance of science today is related to the role of mathematics in its development (Darma & Sepriyanti, 2018). Mathematics is a science that is studied at all levels of education (Eliza & Aulia, 2017). According to Putri, it is not only important in class, but also in everyday life (Putri et al., 2019).

This science is also known as an exact science, because of that not a few students like it. But many also do not like this lesson because this knowledge is also considered abstract. One of the causes of dislike is the unpleasant learning process (Utami, 2018).

Learning is engagement with normative values and a conscious process with purpose (Rabiati & Mardika, 2020). In line with Andi Susanto's theory, the process of assisting students in optimizing their abilities is called learning (Susanto, 2019). The learning model used is an important component in the learning process.

Joyce and Weil expressed their opinion regarding the learning model, which is a design that aims to develop long-term learning, compiling material for both direct learning in class or in any learning place (Khoerunnisa & Aqwal, 2020). Another opinion according to Surur, the use of a methodology, approach and learning technique is referred to as a learning model (Untari, 2020). Then Udin argues, the learning model directs educators and learning designers in the creation and implementation of learning activities (Magdalena et al., 2021). So it can be concluded that the description of the plan made in accordance with the principles used in the teaching and learning process is also called the learning model

Besides being used for the learning process, it can also help develop various abilities, one of which is solving mathematical problems, which is the basis that needs to be owned and mastered to achieve goals, and tools to be able to think analytically, critically, logically, and creatively, so as to foster a mindset to solve the problem. (Yahya & Yulia, 2019). Solving problems is also referred to as intellectual activity which can use existing information to solve problems (Chaidir & Ramdhani, 2023).

According to Andi Susanto and Suzi Qorimah, problem solving is the ability to include determining data completeness, developing mathematical models, selecting and implementing the chosen method, describing results, and verifying their correctness (Susanto & Qorimah, 2020). This problem-solving ability is very important because it can be used in various situations when learning mathematics and its application in other sciences, which also functions to solve real problems (Susanto & Syaveta, 2019).

When students are trained to solve problems, they are also able to make decisions because they have learned to collect and analyze related material, and realize the need to check the results again (Lestari et al., 2020). So it can be said that the ability to solve mathematical problems is very meaningful and should be developed by students at school, because it can be used for their later lives in society in solving various problems that will be passed in real life.

However, when observed from the findings of observations at SMP Negeri 5 Padang. To be precise, it was found in class IX.1 which totaled 31 people, this ability was still relatively low. It appears that when educators apply scientific learning, only a group of students are known to be active. At the beginning of learning, when educators provide material and introduce concepts that are related to real life, only a few respond, which also provides other examples of the relationship between material concepts and everyday life. As a result, they lose interest in learning the material.

Based on an interview with one of the educators of SMP Negeri 5 Padang, he admitted that in the learning process he rarely gives problem solving questions, due to a lack of time when he wants to give them so that it has an impact on students who do not understand the benefits or applications of the learning material and are also not used to facing problem solving matter. As a result, they find it difficult to answer the questions.

This is in accordance with the findings by Arjuna and Lisa that when students are given routine problem solving questions they are able to solve them, but if non-routine problems arise they have difficulties (Rambe & Afri, 2020). To overcome this problem, the ICARE learning model can be applied.

Carni, et al stated that the ICARE model provides an opportunity to apply concepts obtained from the process of solving mathematical problems and constructing their own knowledge, which consists of 5 stages namely introduction, connection, application, reflection, and extension (Carni et al., 2017). This model also has the benefit of applying what has been learned to learning (Mufidah et al., 2020).

Previous research on this matter, which was conducted by Ni Putu Meina Ayuningsih, et al (2020), then by Mufidah", et al (2020). The NOVELTY of this research compared to the previous one lies in the subject, namely class IX students using the 2013 curriculum and problem solving skills mathematical be the dependent variable.

METHOD

Types and Research Design

Quantitative type, Quasi Experiment method (Sugiyono, 2015). Design Randomized Control Group Only Design in experimental and control classes. Each sample class was given a problem solving ability test at the end of the meeting. Look at the following table to see the design (Suryabrata, 2008).

Table 1.
Research Design

Class	Treatment	Test
Experiment	X	T
Control	Y	T

Information :

X : The Mathematics Learning Model uses ICARE

T : Mathematical Problem Solving Ability Test

Y : Scientific Learning

Population and Sample

Population of class IX students of

SMP Negeri 5 Padang. Taking samples using the Random Sampling technique obtained the experimental class IX.7 and the control class IX.3.

Data Collection Instruments and Techniques

Test the ability to solve mathematical problem solving essay 5 questions distributed to students, then collected when finished. A good test is obtained by:

a. Validity Test

Analyzed using the Aiken V formula. Observe Table 2 below to observe the results. Interpretation (Retnawati, 2016):

- If the Index of Agreement $< 0{,}4$ Then validity is low
- If the Index of Agreement $0{,}4 - 0{,}8$ Then validity is moderate
- If the Index of Agreement $> 0{,}8$ Then validity is high

Table 2.
Aiken V Validity Analysis Results

No	Aiken V Index	Validity
1	0,83	High
2	0,92	High
3	0,83	High
4	1,00	High
5	0,92	High

Based on the results of the analysis in Table 2, it shows that the 5 items are valid with a high level of validity.

b. Carry out trials

c. Do analysis

The three parts needed are :

1. Index of difficulty

The results can be seen in the following table.

Table 3.
Results of the Analysis of the Difficulty Index of Trial Questions

No.	$\mathbf{I_k}(\%)$	Information
1	59,77	Moderate
2	67,97	Moderate
3	51,17	Moderate
4	46,48	Moderate

5	43,36	Moderate

As seen in Table 3, it was found that the five questions had moderate criteria.

2. Discriminatory power

The results can be observed in the following table.

Table 4.
Results of the Analysis of Differentiating Power Testing Questions

No.	I_p	Information
1	2,58	Significant
2	3,06	Significant
3	4,67	Significant
4	6,36	Significant
5	16,10	Significant

It can be seen from Table 4 that the five questions are significant.

3. Reliability

To find the reliability, the formula is used, namely: (Suharsimi, 2010)

$r_{11} = \left[\frac{n}{n-1}\right]\left[1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right]$ where

$\sigma_b^2 = \frac{\sum X_b^2 - \frac{(\sum x_b^2)}{N}}{N}$ and $\sigma_t^2 = \frac{X_t^2 - \frac{(\sum x_t^2)}{N}}{N}$

From the calculation results obtained :

$\sigma_t^2 = \frac{X_t^2 - \frac{(\sum x_t^2)}{N}}{N} = 267{,}34$

Then : $r_{11} = \left(\frac{n}{n-1}\right)\left(1 - \frac{\sum \sigma_b^2}{\sigma_t^2}\right) = 0{,}80$

For $N = 31, r_{11} = 0{,}80,$ lies in the interval $0{,}80 \le r_{11} < 1{,}00$ so it can be concluded that the reliability is very high.

Because all three have been fulfilled, the questions can be used and the test can be carried out

Data Analysis Technique

The steps needed are :

1. Normality test

Following are the steps with the Lilliefors test: (Sudjana, 2005)

a. Calculate the average standard deviation. Formula :

$$\bar{x} = \frac{\sum x_i}{n} \text{ and } s_i = \sqrt{\frac{n \sum x_i^2 - (x_i)^2}{n(n-1)}}$$

b. Find standard and raw scores with formulas :

$$Z_i = \frac{x_i - \bar{x}}{S_i}$$

c. Find F(z_i) looking at table Z

d. Find $S(z_i) = \frac{\text{banyak } z_1, z_2, z_3, .., z_n \; yang \le z_i}{n}$

e. Find the difference F(Z_i) and $S(Z_i)$, then determine the absolute price.

f. Then obtained also the value of z_i, $F(Z_i)$, $S(z_i)$ and $|F(Z_i) - S(Z_i)|$ others

g. Take the largest of the absolute price differences expressed in L_0.

Compare price L_0 with critical price L_{tabel} at the level of confidence 95%.

Test criteria :

a) If $L_0 < L_{tabel}$, that the sample is normally distributed.

b) If $L_0 \geq L_{tabel}$, that the sample is not normally distributed.

2. Variance Homogeneity Test

With the F-test, the formula is obtained : (Sudjana, 2005).

$$F = \frac{S_1^2}{S_2^2}$$

3. Hypothesis Test

One-way t-test can be used to test the hypothesis. The formula is as follows (Novianti et al., 2020).

$$t = \frac{\overline{X_1} - \overline{X_2}}{S\sqrt{\frac{1}{n_1} + \frac{1}{n_2}}} \quad \text{with } S = \sqrt{\frac{(n_1 - 1)S_1{}^2 + (n_2 - 1)S_2{}^2}{n_1 + n_2 - 2}}$$

RESULTS AND DISCUSSION

The results can be seen in Table 5. It was shown that the average indicator for the experimental class was higher than the control. According to what was done by Ni Putu Rosma Dewi, et al (2019), it was said that the implementation of the ICARE model learning increased problem-solving abilities, because it was accustomed to and given the opportunity to work on contextual problems, the test results exceeded the KKM set by the school (Dewi et al., 2019).

Table 5.
The Average Score of Students for Each Indicator of Mathematical Problem-Solving Ability

No	Indicator	Average Score	
		Experiment	Control
1	Understanding the Problem	80,32	75,94
2	Planning Completion	88,06	87,81
3	Carrying out the settlement plan	84,68	77,81
4	Check Back	63,87	33,91
	Average	79,23	68,87

To conclude the data from the test results, statistical analysis can be carried out. First do the following two things.

a. Normality test

Based on the calculation obtained.

a. $\overline{\boldsymbol{x}} = \frac{\sum x_i}{\boldsymbol{n}} = 79{,}23$

b. $S_i = \sqrt{\frac{n\sum x_i^2-(\sum x)^2}{n(n-1)}}$

$= 11{,}77$

c. $Z_i = \frac{x_i-\bar{x}}{S_i} = \frac{53-79{,}32}{11{,}77} = -2{,}23$

d. $F(z_i) = F(-2{,}23) = 0{,}0126$

e. $S(z_i) = \frac{1}{31} = 0{,}0322$

f. $|F(Z_i) - S(Z_i)| = 0{,}0196$

g. Obtained value of z_i, F(Z_i), $S(z_i)$ and $|F(Z_i) - S(Z_i)|$ others.

$L_0 =$ biggest price $[(Fz) - S(z)]$

Then the conclusion obtained can be seen in Table 6.

Based on Table 6 it is concluded that the sample is normal.

Table 6.
Sample Normality Test Results with the Lilliefors Test

No	Class	L_0	L_{table}	Conclusion	Keterangan
1	Experiment	0,091	0,159	$L_0 < L_{table}$	Normal
2	Control	0,093	0,157	$L_0 < L_{table}$	Normal

b. Homogeneity Test

The calculation is as follows.

$S_1^2 = \frac{n\sum x_1^2-(\sum x)^2}{n(n-1)}$

$= 138{,}42$

$S_2^2 = \frac{n\sum x_2^2-(\sum x)^2}{n(n-1)}$

$= 201{,}00$

$F = \frac{S_1^2}{S_2^2} = \frac{138{,}42}{201{,}00} = 0{,}69$

Testing Criteria :

H_0 accepted if $F_{hitung} < F_{tabel}$

The value F_{tabel} at the level $\alpha =$ 0,05 with degrees of freedom (31-1,32-1) is 1,83 then $F_{hitung} < F_{tabel}$ is $(0{,}69) < (1{,}83)$ and H_0 is accepted. So in conclusion the samples are homogeneous.

c. Uji Hipotesis

Here's the calculation.

$\overline{x_1} = 79{,}23$

$S_1^2 = 138{,}42$

$n_1 = 31$

$\overline{x_2} = 68{,}87$

$S_2^2 = 201{,}00$

$n_2 = 32$

$t = \frac{\overline{X_1}-\overline{X_2}}{s\sqrt{\frac{1}{n_1}+\frac{1}{n_2}}} = 3{,}16$

Where s can be obtained using the formula :

$S^2 = \frac{(n_1-1){S_1}^2+(n_2-1){S_2}^2}{n_1+n_2-2} = 170{,}22$ $S =$ 13,04

$\alpha = 0{,}05$ and
$df = n_1 + n_2 - 2 = 31 + 32 - 2 = 61$
obtained $t_{hitung} = 3{,}16$ and $t_{tabel} = 1{,}99$ the level confidence 95%. Because $t_{hitung}(3{,}16) > t_{tabel}(1{,}99)$, then H_0 is rejected dan H_1 is accepted.

The next section details indicators of mathematical problem solving ability with the steps of the ICARE model.

a. Understanding the Problem Indicator.

It means being able to arrange objects that have not been properly arranged (Wulan & Anggraini, 2019). Based on the results of the study, it can be seen that the indicators of understanding the problems of the experimental class are higher.

Because at the Introduction stage, namely the introduction, the teacher raises initial knowledge about the material to be studied then records the points presented, then students ask questions of what is not understood. This question and answer interaction can guide them to understand the problem to be solved. At this stage the indicator of understanding the problem increases.

In the control class this indicator was lower because they only received explanations from the teacher, and were also not used to building their own knowledge which should help them understand the problem. Only one or two people want to ask when given the choice to do so because they only want to hear what the educator is explaining.

b. Indicator Planning Completion

Indicators of planning a solution are seen when students determine a mathematical model of a problem and solve it (Alghadari, 2016). Based on the results of the study, it can be seen that the indicators for planning the completion of the experimental class are higher. Because at the Connection stage, namely the connecting stage, educators remind about what has been taught and relate it to what will be learned.

This activity can connect students to find the right solution plan for the problem given. This is what can help them in improving indicators to plan problem solving.

The indicator for planning the completion of the control class is lower than the experiment because in the control class when they are reminded again about the concept of the previous material, they pay less attention and think that it does not need to be studied again because it has already been studied before.

c. Indicator of Carrying out the Settlement Plan

This indicator appears when students choose and construct solutions that include the ability to produce many possible ways that can be used (Chotima et al., 2019). From the results of the study, it appears that the indicator of carrying out the experimental class completion plan is higher. Because at the Application stage, namely application and Extension, namely advanced training.

At this stage, they are used to solving questions on LKPD in the form of problem solving. Students can discuss with their group members, if there are obstacles in solving the problem students can discuss it together to get the right solution. Students are also given individual exercises used as reinforcement of understanding. With this increasing indicator of carrying out the problem solving plan.

In the control class, the indicator of carrying out the completion plan was lower because the students did not do the exercises in groups but did them alone. Therefore, if constrained in completing answers, students are too lazy to continue.

d. Looking Back Indicator

Indicators of re-checking can be seen when students try to re-check and thoroughly review each stage of the solution they made (Indarwati et al., 2014). This indicator in the ICARE model can be seen at the Reflection stage, namely the teacher guides students to repeat and re-check the process that has been done.

By re-examining the solution, it can help them better understand what they have learned. Some of them seemed to be involved in proposing various solutions during the group presentations. This difference of opinion and the results of each group led to discussions between groups.

Such things can produce learning situations that are more lively and enthusiastic, and teach students how to express their opinions. If the class as a whole encounters difficulties, the educator invites students to check the steps for completion and the final answer they get together. This can help in improving the Looking Back indicator.

For indicators of re-checking the control class is lower than the experiment because the control class does not re-check the process that has been carried out and the solution is obtained. Students assume that if the problem has been completed and the results have been obtained, the process of working on the problem has also been completed without the need to ridicule the results whether they are right or wrong.

Unlike the control class experienced. Students do not find the learning experience as felt by the experimental class. The class applies scientific learning, students generally listen to explanations from educators, pay attention to educators and record what educators present. The teacher also asks them to re-read and understand what has been recorded, then do the practice questions given, and are given time to ask questions. Although given the opportunity, very few Among them issue their questions at each meeting.

These results also match those carried out by Hapsari, the ICARE learning model is effective and useful, learning outcomes increase by 18.5% (Hapsari et al., 2019). Furthermore Hadi concluded that by applying this model, his learning outcomes increased (Hadi, 2022).

CONCLUSION

It was concluded that by applying the ICARE learning model, students' mathematical problem solving abilities were higher than scientific learning. Researchers who are interested in applying the ICARE learning model as a substitute for or other solutions in learning should further develop it, for example using realistic math-based worksheets or learning media such as geogebra, and others. It is also suggested that researchers use a larger sample and a wider range of learning materials to assess other mathematical abilities, as well as students' abilities in other subjects. If this is done, researchers will be able to find out the relevance of this model in learning in more depth.

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