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PQ4R Strategy (Preview, Question, Read, Reflection, Recite, Review) for Mathematical Communication Ability

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***Abstract*—Students University of Indraprasta PGRI Jakarta by using PQ4R (Preview, Question, Read, Reflection, Recite, Review) Learning. This research is a quasi-experimental search using purposive sampling technique. The population in this study were all 6th semester students, and the study sample was two classes. Of the two classes are classified into two groups of learning, namely learning groups with PQ4R strategies and conventional learning. Y6B class is used as an experimental group, while Y6D class is used as a control group. Data analysis is done quantitatively. Quantitative analysis was carried out by calculating N-gaint using normality test, and Mann-Whitney U test. The data were collected through pretest and posttest tests. The results of the study show that the improvement of students' mathematical communication skills that get learning with the PQ4R Strategy is better than students who get conventional learning.**

Keywords—PQ4R (preview, question, read, reflection, recite, review); mathematical communication

I. INTRODUCTION

The attraction of mathematics is the ability to explore, construct conjectures, give logical reasons, the ability to solve non-routine problems, communicate ideas about mathematics and use mathematics as a communication tool, connect ideas in mathematics, between mathematics, and other intellectual activities [1]. Through mathematical communication and reading, teachers can foster student involvement and participation while focusing on understanding [2]. Mathematical communication is written communication skills and expressed through representation as expressed by Jakabcsin [3], Jati et al. suggests several mathematical communication activities as follows [4]: a) Mathematical writing, b) Mathematical drawing, c) Mathematical expression. Which details some of the mathematical Communication Capability processes (MCA) as follows [5, 6]: a) Expressing mathematical situations or problems, or everyday life situations into mathematical figures, diagrams, or symbols or mathematical models; b) explain mathematical ideas, situations, and relationships by using objects, pictures, graphics, algebraic expressions, or their own language in writing or verbally; c) compile a story based on the figures, diagrams, or mathematical models presented; d) To ask questions about the mathematical content presented. Pugalee says that students need to be accustomed to giving arguments for each answer and giving responses to answers given by others, so that what is being learned becomes more meaningful to him [7]. Lomiboa also argues that communication skills play a central role in the development of cognitive structures and that language is a means, not only to represent experience, but also to transform ideas [8]. In line with the statement above the ability to communicate ideas in mathematics learning needs to be developed both at school and in college, therefore the students of Indraprasta University PGRI need to develop and improve communication skills given that students of mathematics programs study in University of Indraprasta PGRI are prospective mathematics teachers, who should have mathematical communication well [9]. For successful learning to occur the teacher needs to effectively communicate mathematics. The things that indicate the low mathematical communication skills of students of Indraprasta University when faced with problems presented in the form of story problems students are still confused about how to solve them, they have difficulty in making mathematical models, this is evident when given problems in the subject matter of linear programs.

Linear program is a compulsory subject taken by students of the Mathematics Education Study Program at Indraprasta University. Linear program form the basis of other mathematics courses, especially in applied mathematics. Based on the results of observations in sixth semester in working on linear program questions, many students experienced difficulties in completion, and the learning outcomes were not satisfactory. Many errors occur when students are assigned to determine the optimum value of a case. The absorption of students in linear program material is very determining the optimum value is still very low. The most common mistake for students is a transformation error. This happens because students are wrong in transforming the sentence contained in the problem into a mathematical model. Examples of errors in this type can be seen in the following cases.

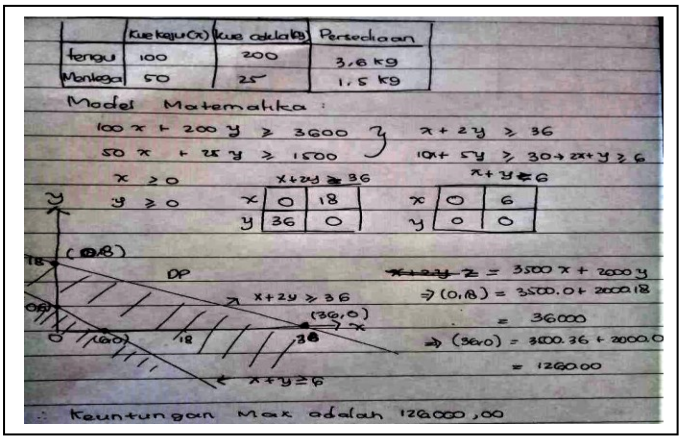


Fig. 1. Students are wrong in changing sentences on math problems.

Figure 1 shows that students are wrong in changing sentences on math problems, so the next process to get answers is wrong. It can be indicated that the cause of student errors is that students do not master the prerequisite material that is linear inequality, and students are less careful in making mathematical models. In addition, errors that often occur are confuse in determining the point of intersection of the function graph and errors in writing answers. This is because students experience difficulties in expressing real situations or objects into the language of symbols, ideas, or mathematical models. They are accustomed to calculating basic calculations and procedural questions and the lack of solving contextual problems that demand argumentation and creativity in solving them. In addition Nahkanu stated that in addition linear programming skills are not mastered by the time the learners leave high school [10]. From the answers above, the researcher concludes that the students' communication skills are still low in linear program, because there are errors that are related to mathematical communication indicators such as: students are still wrong in expressing situations, pictures, diagrams or real objects into symbols, ideas, or real objects into language of symbols, ideas, or mathematical models. So that it results in other errors in expressing, demonstrating and describing mathematical ideas in the form of images, tables, graphs.

Several studies related to the low level of students' seriousness in the subject matter of linear programs at the high school and college level [11]. Several studies related to the lack of mathematical communication skills and efforts to improve mathematical communication skills have also been carried out, namely in junior high, high school and college level students [8, 12, 13]. The results of international research such as the Program for International Student Assessment (PISA) in 2015 showed that Indonesia ranked only 62 out of 70 participating countries with an average score of 386 [14]. Mathematical literacy in PISA focuses on the ability of students to analyze, reason and convey ideas effectively, formulate solving, and interpret mathematical problems in various forms and situations. Thus shows that in Indonesia students' mathematical communication skills still have to get a lot of attention.

To achieve learning objectives, especially mathematical communication, choosing the right learning strategy can be a success factor. The learning theory of constructivism is based on the work of Jean Piaget and Lev Vygotsky and is the leading theory of learning today [15-17]. One of the strategies that can improve memory performance in understanding lessons is the PQ4R strategy. The PQ4R learning strategy consists of several stages, a preview where students must scan reading material to find the main structure of the topic and subtopics [17]; students must pay attention to the title, subtitle, and identification found. The next step is the question that refers to questions related to the material using the question word, what, who, where, when, why, and how. The third stage is read which refers to comprehensive reading activities; students might try to answer their own questions. Reflection refers to understanding information obtained from reading activities by (1) connecting each part of information from all students; (2) linking subtopics of reading texts with the main concepts; (3) resolve contradictions; and (4) answer questions that arise related to the text. Reading means students must remember that information. Reading means that students must re-investigate learning material, focus on their own questions, and they can reread the text if necessary. Several studies related to the PQ4R strategy, at the elementary school level Misykah explain about the effect of PQ4R strategy and Intellectual Intelligence on higher thinking ability in mathematics in elementary schools strategies at the high school, concluded that the high-level thinking skills of students learning with the PQ4R learning strategy were higher than the high-level thinking skills taught by the expository learning strategy [18]. PQ4R strategies at high school level Tandililing explain about the enhancement of mathematical communication and self-regulated learning of senior high school students through PQ4R strategy accompanied by refutation text reading [19], this study found that learning with the PQ4R strategy accompanied by Refutation Text Reading had a consistent effect compared to conventional learning Other related research results at the college level Klenden explained that the PQ4R learning method is more effective than the lecture method in terms of achievement aspects and learning motivation of students of mathematics education study programs [20].

Previously, researchers investigated various studies on students' mathematical communication, both at the secondary school level and at the college level, test students' mathematical communication skills through Treffinger's learning model, overall results, achievements and improve communication skills of students who get Treffinger's learning higher than students who get conventional learning [21]. Barnas examine the role of SQ3R strategies in students' mathematical communication skills and self-regulated learning, it was concluded that SQ3R class students had achieved better quality than the quality of students who received conventional learning [5]. Testing the mathematical communication skills of vocational students with guided inquiry models, the results show that mathematical communication skills of experimental class students are better than conventional class students [22].

II. Eksperiment Method

This study aims to determine the improvement of students' mathematical communication skills with PQ4R strategy learning. This research is quasi-experimental so that subjects are not randomly grouped but are chosen based on groups that have formed naturally. The quasi-experiment design of this study is as follows:

Experiment Class : O X O
Control Class : O O
Where : X : PQ4R Strategy Learning
O : Giving Pretests and Postes
- - - - - - - : Subjects are not randomly grouped

This research was conducted at Indraprasta University PGRI Jakarta The population in this study were all sixth semester students with a study sample consisting of two classes, Y6B class as the experimental class and Y6D class as the control class. Determination of the sample in this study does not allow pure randomization. Therefore, the sampling that is possible to do is 'purposive sampling' the sample is chosen deliberately with certain considerations.

The math communication skills test is prepared as follows:

1. Make a grid of questions that include sub-topics, the difficulty level of each item, and the number of questions that must be made.
2. Arrange the test questions for mathematical communication skills.
3. Assess the suitability of the material, indicators and test questions to determine the content validity and face validity

Indicators of mathematical communication skills used in this study include: 1. Expressing, demonstrating and describing mathematical ideas in the form of images, tables, graphs or other mathematical models, 2. Making situations, images, diagrams or real objects into language symbols, ideas, or mathematical models, 3. Analyze and evaluate the information provided.

Determine the score for increasing mathematical communication skills with normalized N-gain formula, as follows:

$$\text{Normalized gain} = \frac{\text{posttest score} - \textit{pretest}\ \text{score}}{\text{maximum possible score} - \textit{pretest}\ \text{score}}$$

The results of the N-gain calculation are then interpreted using the following classification:

TABLE I. Classification N-Gain

N-gain (g)	Classification
$g \geq 0{,}70$	high
$0{,}30 \leq g < 0{,}70$	medium
$g < 0{,}30$	low

Data analysis was performed using SPSS version 16. Quantitative analysis was carried out by calculating numbers using the normality test, and the Mann-Whitney U test.

III. Result and Discussion

Mathematical communication skills test data were obtained from 58 students, consisting of 29 experimental class students who received learning with the PQ4R strategy and 29 control class students who received conventional learning. The analysis of N-gain scores on mathematical communication ability using normalized gain data, normalized gain data also shows the classification (quality) of increasing student scores compared to the ideal maximum score. The average N-gain illustrates the improvement of students' mathematical communication skills in the experimental class and the control class.

TABLE II. Average N-Gain Classification of Mathematical Communication Capabilities

Class	Mean	Classification
Control	0,655	Medium
Experiment	0,780	High

Table 2 show that the results of the experiment class calculation have a higher average N-gain score than the control class. Classification of N-gain scores for the two classes is different, the experimental mean is in the high category while the control class is in the medium category, with a difference in score of 0.13. However, to ensure whether it is true that the improvement of mathematical communication skills of the experimental class students is better than the control class students, it is necessary to carry out advanced statistical tests. Statistical tests are needed to see the hypothesis which states "improvement in mathematical communication skills of students who get learning with the PQ4R strategy is significantly better than students who get conventional learning" that is the test of the difference in the average N-gain score, before testing the N-gain score data must meet the prerequisite test for normality.

TABLE III. Normality Test for N-gain Score

Class	Kolmogorov- Smirnov[a]			Conclusion
	Statistic	*Df*	*Sig.*	
Experiment	0,119	29	0,200	Normally distributed
Control	0,119	29	0,003	Not normally distributed

Table 3 show that the results of the calculation of the N-gain score of the students' mathematical communication ability of the PQ4R learning strategy is normally distributed with 0.200> α = 0.05 while the conventional class has a value of 0.003 <α = 0.05 not normally distributed. Because one class shows that the N-gain score data communication capability is not normally distributed, the two average gain difference test uses nonparametric test.

TABLE IV. TEST OF DIFFERENCE IN N-GAIN SCORE

Statistics	Value	Explanation
Mann-whitney U	201,000	Ho Rejected
Z	-3,416	
Asymp. Sig. (2-tailed)	0,001	

Table 4 show that results of the *Man-Whitney U* the p-value or Sig. (2-tailed) which is 0.001 for the one-party test Sig. (1-tailed) which is $\frac{0.001}{2} = 0.005$. Then obtained Sig. (1-tailed) $0.005 < \alpha = 0.05$. This shows that H_0 is rejected, meaning an increase in students' mathematical communication skills that implement PQ4R strategy learning strategies are significantly better than conventional class students.

The increase in mathematical communication skills through PQ4R strategy learning is caused by the fundamental differences that occur during the learning process in PQ4R and conventional classes. In conventional classes students get knowledge about facts, concepts and procedures such as rules and formulas from the teacher and source books. Whereas in the PQ4R class that happens is the opposite, PQ4R learning according to Setiawan, Ramdiah, and Kleden includes Preview activities where students read briefly to find the main ideas/learning objectives to be achieved, activities the question is that students pay attention to the teacher's explanation and answer the questions he has made, the Read activity is that students read actively while giving responses to what they have read and answer the questions they make, the Reflect activity that is students try to solve problems from information provided with known knowledge through reading material, the Recite activity is that students ask and answer questions and make essence, and the Review activity is that students read the essence that they have made and re-read the reading material [16, 23, 24]. In the research on the question stage at the beginning of learning students are faced with problems on the worksheet which serves to provide stimulus and trigger students to think and ask, then in the reflection and recite stages students construct ideas from the given teaching material. The final stages of student review are faced with a variety of challenging problems that can present students' thinking activities in solving mathematical problems that involve students doing active math processes, restating the mathematical ideas in forming new understandings. The concept of learning like that, can facilitate students in building ideas with a group of friends.

Based on the analysis of research data, there were findings that occurred at the time of the study, in which the increase in mathematical communication of students who received PQ4R learning was higher. It can be seen from the three mathematical communication indicators examined in PQ4R learning and conventional learning that there is one indicator that is said to provide maximum results, there are indicators that express, demonstrate and paint mathematical ideas in the form of pictures, tables, graphs or mathematical models other. The following Figure 2 is an example of the communication problem provided:

From the communication problem above students are expected to be able to change a picture or a verbal problem situation into a mathematical model or in other words change the presentation in everyday language into mathematical language that is as simple and easy to understand. Figure 3 show the results of student work:

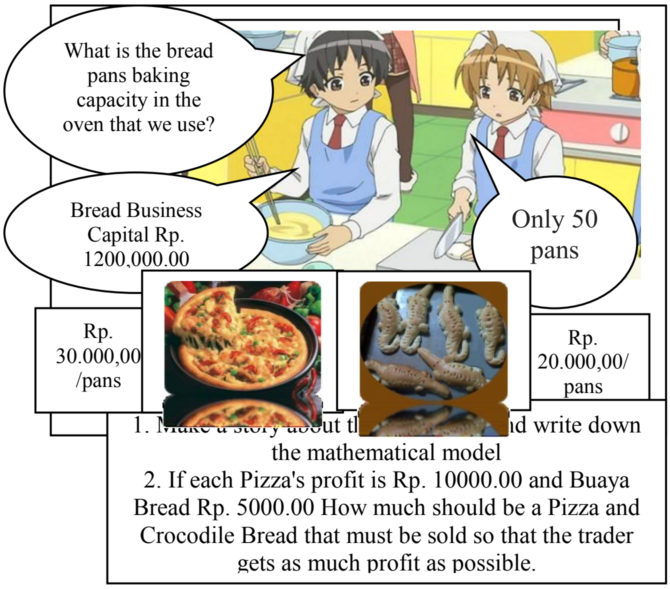
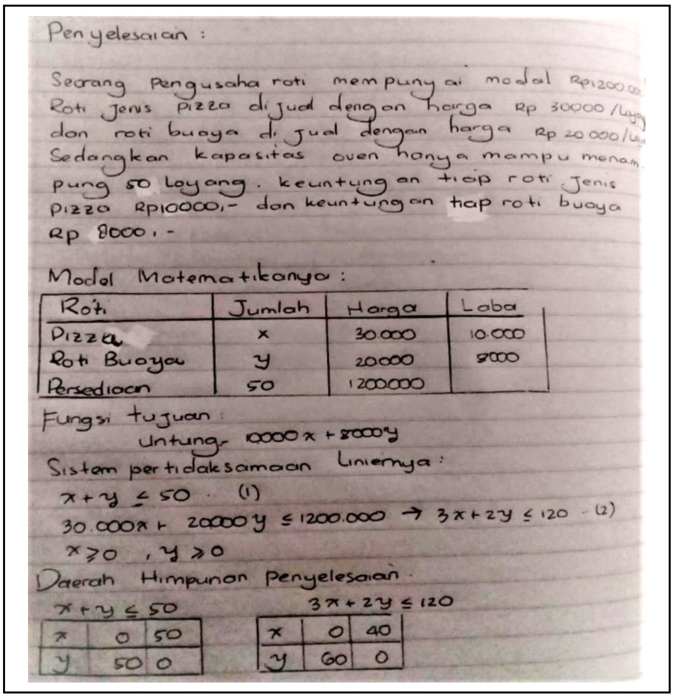


Fig. 2. Examples of communication problems.



Penyelesaian :

Seorang Pengusaha roti mempunyai modal Rp1200.00 Roti Jenis pizza dijual dengan harga Rp 30000 /Loyang dan roti buaya dijual dengan harga Rp 20.000/L Sedangkan kapasitas oven hanya mampu menampung 50 Loyang. keuntungan tiap roti Jenis pizza Rp10000,- dan keuntungan tiap roti buaya Rp 8000,-

Model Matematikanya :

Roti	Jumlah	Harga	Laba
Pizza	x	30.000	10.000
Roti Buaya	y	20000	8000
Persediaan	50	1200000	

Fungsi tujuan :
Untung = $10000x + 8000y$

Sistem pertidaksamaan Liniernya :
$x + y \le 50$ (1)
$30.000x + 20000y \le 1200.000 \rightarrow 3x + 2y \le 120$ (2)
$x \ge 0$, $y \ge 0$

Daerah Himpunan Penyelesaian

$x + y \le 50$

x	0	50
y	50	0

$3x + 2y \le 120$

x	0	40
y	60	0

Fig. 3. The results of student work on mathematical communication questions.

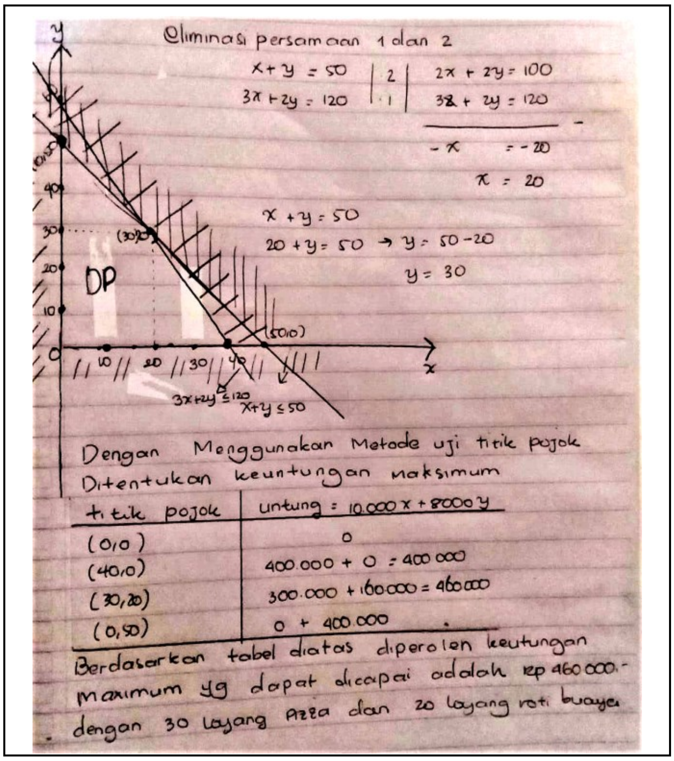


Fig. 4. The results of student work on mathematical communication questions.

Based on the results of the student work above, it can be seen that students are able to express, demonstrate and paint mathematical ideas into other mathematical models. Analysis of research data shows that students' mathematical communication skills who learn with PQ4R learning are better than conventional learning. These findings indicate that learning mathematics with PQ4R learning has a positive influence on students' communication skills. This provides an illustration that PQ4R learning provides a good contribution in developing students' mathematical communication skills. Increased communication skills in PQ4R learning are also caused by group work that runs well, where during the learning process students are trained to solve mathematical problems using logical arguments by connecting facts, pictures and information given to the problem. As a result, students are increasingly accustomed to expressing their opinions with logical reasons.

IV. Conclusion

The results of the data analysis above show that the improvement of students' mathematical communication skills who learn with the PQ4R learning strategy is better than conventional learning. This means that the PQ4R strategy has a positive influence and provides a good contribution to students' mathematical communication skills. The increase in communication skills in the PQ4R class is caused by the learning process where students are trained to solve math problems by using logical arguments and connecting facts, pictures and information given to the problem. As a result, students are increasingly accustomed to expressing their opinions accompanied by logical reasons.

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