The Relationship between The Postsecondary Education Readiness Test (PERT) Mathematics Score and Students’ Mathematics Problem-Solving Ability

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Abstract. The study aimed to determine the relationship between PERT mathematics scores and students’ mathematics problem-solving ability. This study uses the correlation research design to determine the relationship between the two variables. The sample consisted of 29 freshmen students who have passed the PERT mathematics test and take college algebra class. The main instrument in this study is worksheet consists of two problem-solving questions. The PERT mathematics scores were used as the predictor variable of this research. Based on the SPSS analysis, the r score was 0.547, which describe that there exists a correlation between the PERT mathematics score and students’ mathematics problem-solving ability. The variation of PERT mathematics score can explain about 29.9% of the variation of students’ problem-solving ability. The rest 70.1% supposed to be explained by other factors. The results of these preliminary research studies can provide invaluable information on the direction of future research that may be required on the specific variables.

Key words: PERT; problem-solving; mathematics.

1. Introduction

The rapid development of technology and information has led every country to prepare better future generations to be ready for a more challenging global competition. According to Dibenedetto et al. (2016), future generations will need to be equipped with the essential knowledge, skills and dispositions to answer the challenges in the 21st-century global workplace. In many situations found in today’s workplace, complex problems are often found along with the development of technology and information. For instance, employees are asked to find ways to reach prospective markets or to redesign a product to minimize the cost of materials. Therefore, thriving employees have to possess creative ideas in order to solve a complex problem with a real set of requirements and constraints. Problem-solving becomes one of the essential skills needed to succeed not only in the workplace but also in daily life.
An individual who excels in problem-solving will be able to solve complex problems with more than one solution and be able to compare and to contrast alternative solutions in facing significant aspects of complex situations set in the future. NCTM (2000) boldly states that problem-solving should be an integral part of all mathematics learning, not an isolated part of the mathematics program. Thus, problem-solving become one of the most important aspects of mathematics across all phases of education, including at the university level.

One of a private university located in Jakarta has the vision to aspire to foster future leaders with strong moral character and internationally competitive skills sets, enabling them to actively participate in building a more prosperous, equitable, respected, and globally competitive Indonesia. The university applies an international standard higher education system to achieve its vision. The university admissions policy requires new students to meet the minimum necessary qualifications for acceptance. The first-year students must demonstrate college readiness in English and Mathematics by completing a standardized assessment, i.e. the Postsecondary Education Readiness Test (PERT). Currently, all first-year students who have passed the PERT mathematics minimum score will be eligible to take the College Algebra course in the first semester.

The university may put more attention to students' problem-solving ability in order to ensure that students meet the graduate profile by the end of the study and becoming future leaders who can compete globally in the workplace. Therefore, it might be useful to obtain information about the relationship between PERT mathematics scores with students' problem-solving abilities. The purpose of this research is to determine the linear relationship between the PERT mathematics score and students' mathematics problem-solving ability. If a linear relationship exists, the researchers are to determine a regression equation that could be used to make predictions to a population. Furthermore, once a correlation has been established, findings can be used by researchers to make predictions and construct hypotheses for future research.

2. Methodology

2.1 Research Design

The type of this research is correlational research, which refers to its main purpose, to discover the relationships between variables through the use of correlational statistics (Gall, Borg, & Gall, 2003). A correlational study describes the degree of relationship between two or more quantitative variables, and it does so by using a correlation coefficient (Fraenkel, Wallen, & Hyun, 2011). Two main variables are expressed in the research questions stated previously for the quantitative study:

Predictor variable: Students’ PERT score test

The Postsecondary Education Readiness Test (PERT) is a standardized test administered to Florida high school students and those who are entering college in the state. Individuals who earn a score of 110-122 can enrol in intermediate Algebra, a college-level math class.

Criterion variable: Students’ Ability in mathematical problem-solving.

Students’ ability in mathematical problem-solving measured/ scored by using the following rubric:

| Problem Solving Phase | Score | Observation or Inference                      |
|-----------------------|-------|-----------------------------------------------|
| Understanding the problem | 0     | Complete misunderstanding of the problem     |
|                        | 1     | Part of the problem misunderstood or misinterpreted |
|                        | 2     | Complete understanding of the problem         |
| Planning a solution | 0 | No attempt, or wrong answer based on an inappropriate plan |
|--------------------|---|--------------------------------------------------------|
|                    | 1 | Partially correct plan based a part of the problem being interpreted correctly |
|                    | 2 | Plan could have plat to a correct solution if implemented properly |
| Carrying out       | 0 | No answer, or wrong answer based on an inappropriate plan |
|                    | 1 | Copying error; computational error; partial answer for a problem with multiple answer |
|                    | 2 | Correct answer and correct label for the answer |

The rubric was adopted from Charles, R., Lester, F., & O'Daffer, P. (1987). *How to evaluate progress in problem-solving*, Reston, VA: National Council of Teachers of Mathematics

2.2. Research setting and respondents

**Population Characteristics**
The population in this study is the first-year university students who have passed the PERT mathematics score and enrol in a college algebra course.

**Sampling Procedure**
The researcher selects a sample of research participants who have the characteristics that are represented by the independent and dependent variables. The sampling procedure uses a convenience sampling in which the researcher uses the subjects that are available to participate in the research study. The researcher will select 1 class with a schedule fit with the researcher’s availability.

**Sample Size**
There are 29 participants in will be involved and ask to answer problems in mathematics.

2.3. Techniques of data collection

The researchers will observe students in College Algebra class solving two mathematics problems, and then collect the answer sheets, and analyze students’ solutions using the problem-solving rubric. The problem-solving questions have been reviewed by two experts and finalized based on the experts’ feedback. The students’ solutions used to evaluate students’ problem-solving ability in mathematics, according to Polya’s Framework.

2.4. Data validity

The problem-solving questions will be reviewed by minimum two experts and revised based on the experts’ feedbacks. The students’ problem-solving abilities will be measured based on the rubric presented in Table 1. The researchers will include minimum two research assistants to analyse the students’ worksheet.

2.5. Data analysis

Descriptive statistics for the independent and dependent variables computed. Bivariate correlational statistics used to determine the relationship between two variables.

**Hypotheses**
To determine whether there is a significant linear correlation between two variables, use the following null and alternative hypotheses that use $\rho$ to represent the linear correlation of the population:

$$H_0: \rho = 0$$
$$H_1: \rho \neq 0$$
Null Hypothesis: there is no linear relationship between the PERT Mathematics Score and Students’ Mathematics Problem Solving Ability.

The research hypothesis: there is a linear relationship between the PERT Mathematics Score and Students’ Mathematics Problem Solving Ability.

\textit{Test Statistic}

The \( t \) test statistic is as follow:

\[ t = \frac{r}{\sqrt{1 - r^2}} \sqrt{n - 2} \]

Where \( r \) represent the linear correlation coefficient for sample data and \( \rho \) represent the linear correlation for a population of paired data. The level of significance is 0.05. The degrees of freedom (df), which approximates the sample size is \( n - 2 = 29 - 2 = 27 \).

3. Results and discussion

3.1 Results

All students who became the research participants have passed the minimum threshold for PERT mathematics score and considered as college ready students, thus they were eligible to enrol in College Algebra course. Those students were asked to solve two questions of mathematics problem-solving as follows:

| Table 2. Problem-Solving Questions |
|-----------------------------------|
| Problem 1: Bambang is 6 years more than twice Tono’s age. 2 years ago, Bambang was three times as old as Tono. How old was Kim 2 years ago? (adapted from Spiegel, M. (2009). Schaums Outline of College Algebra, Third Edition) and the second question is adapted from Kaur, B. (2008). Problem Solving in the Mathematics Classroom (Secondary). Singapore: National Institute of Education. |
| Problem 2: On a farm, there are cows, chickens, and snakes. Altogether they have 12 heads and 30 legs. How many cows, how many chickens and how many snakes are there? (adapted from Kaur, B. (2008). Problem Solving in the Mathematics Classroom (Secondary). Singapore: National Institute of Education. |

The PERT mathematics scores and students’ problem-solving ability scores are presented in Table 3 as follows.

| Table 3. PERT Mathematics Scores and Problem-Solving Scores |
|-----------------------------------------------------------|
| Code | A15 | A16 | A17 | A18 | A19 | A20 | A21 | A22 | A23 | A24 | A25 | A26 | A27 | A28 | A29 |
| PERT | 140 | 123 | 125 | 128 | 140 | 135 | 134 | 150 | 123 | 126 | 150 | 128 | 124 | 115 | 111 |
| PS   | 5   | 0.55 | 2.25 | 2.55 | 5.1 | 2.55 | 3.35 | 3.55 | 0.9 | 2.35 | 4  | 0   | 0   | 1.35 | 5.1 |
| Code | A1  | A2  | A3  | A4  | A5  | A6  | A7  | A8  | A9  | A10 | A11 | A12 | A13 | A14 |
| PERT | 124 | 135 | 141 | 124 | 128 | 132 | 136 | 127 | 127 | 129 | 132 | 129 | 138 | 135 |
| PS   | 2.75 | 3.9 | 2.65 | 1.1 | 0.9 | 2.45 | 0   | 0   | 2   | 2.25 | 3.65 | 1.35 | 3.35 | 3.55 |

Based on the SPSS analysis results, the minimum PERT mathematics score was 111, while the maximum score for the PERT mathematics score was 150. The mean score of PERT mathematics was 130.6552, with a variance of 77.591. Moreover, the minimum score of students’ problem-solving ability
was 0.00, and the maximum score was 5.10. The mean score of students’ problem-solving ability was 2.2810, with a variance of 2.139. The details information of descriptive statistics of the two variables can be seen in Table 4.

**Table 4. Descriptive Statistics of Two Variables**

|       | N  | Range | Minimum | Maximum | Mean  | Std. Deviation | Variance |
|-------|----|-------|---------|---------|-------|----------------|----------|
| Statistic | Statistic | Statistic | Statistic | Statistic | Mean  | Std. Error |
| PS    | 29 | 5.10  | .00     | 5.10    | 2.2810| 1.46241       | 2.139    |
| PERT  | 29 | 39.00 | 111.00  | 150.00  | 130.6552| 8.80858       | 77.591   |
| Valid N (listwise) | 29 |

The correlation statistics analysis between the PERT mathematics scores and students’ problem-solving ability is computed using SPSS and the result is presented in Table 5.

**Table 5. Correlations between Two Variables**

|       | PERT | PS  |
|-------|------|-----|
| Pearson Correlation | 1    | .547 |
| Sig. (2-tailed)      | .002 |     |
| Sum of Squares and Cross-products | 2172.552 | 197.310 |
| Covariance           | 77.591 | 7.047 |
| N                   | 29   | 29  |

Based on the correlation analysis in table 4, we have the linear correlation coefficient is 0.547 and \( n - 2 = 27 \), so the test statistics is

\[
 t = r \sqrt{\frac{n - 2}{1 - r^2}} = \sqrt{\frac{0.547}{1 - 0.547^2}} = 3.395275.
\]

To check the significance level of 0.05, we reject \( H_0 \). We conclude that there is sufficient evidence to support claim that there is a linear correlation between the PERT mathematics score and students’ problem-solving ability.

Since the linear correlation coefficient \( r \) indicates that there is a linear correlation between the two variables, we can use the regression equation to see the effect on one variable when the other variable changes by some specific amount. The regression analysis using SPSS is presented in Table 6.
Table 6. Model Summary and Parameter Estimates

| Equation  | R Square | F      | df1 | df2 | Sig. | Constant | b1 |
|-----------|----------|--------|-----|-----|------|----------|----|
| Linear    | .299     | 11.530 | 1   | 27  | .002 | -9.585   | .091|

The independent variable is PERT.

Based on the information in Table 6, the regression equation is $y = -9.585 + 0.91x$. The scatter plot that illustrated the regression equation can be found in Figure 1 as follow.

Figure 1. The Scatter Plot between Two Variables

The slope of the equation tells us that if we increase $x$ (the PERT mathematics score) by 1 point, the predicted students’ problem-solving ability will increase by 0.091. That is, for every additional 1 point of the PERT mathematics score, we expect the students’ problem-solving ability score to increase by 0.091. Furthermore, since $r^2$ is the proportion of the variation that can be explained, we conclude that about 29.9% of the total variation in students’ problem-solving ability score can be explained by the students’ PERT mathematics score. This implies that about 70.1% might be explained by other factors.

3.2 Discussion

Based on the correlation analysis results, we found that the correlation coefficient was 0.547, which means that the relationship between the PERT mathematics score and students’ problem-solving ability exists. Moreover, according to the value of $r^2$ which equal to 0.299, we infer that the students’ PERT mathematics score can explain about 29.9% of the total variation in students’ problem-solving ability score. Thus, the remainder 70.1% might be explained by other factors. These findings affirm that the linear relationship between the two variables did exist and considered as positive moderate or not strong enough. There exist other factors that might be better explained the variance of students’ problem-solving ability.
The descriptive statistics analysis in Table 4 also confirmed that although all students have passed the minimum score of PERT mathematics and considered as college-ready, some of them were immensely struggling in dealing with mathematics problem-solving questions. Four students were not able to perform any solution for the given problem-solving questions. In general students’ PERT math scores were higher than students’ problem-solving ability score. Meyer (1978) noted that although certain prerequisite mathematical concepts and skills are related to problem-solving success, a knowledge of these concepts and skills is not sufficient for successful problem-solving. Success in problem-solving depends upon the metacognitive process, as described by Liljedahl P. et al. (2016).

Contrast with the PERT mathematics, which focuses on solving basic math problems in the form of multiple-choice questions. Although the PERT math test includes word problems using real-world situations, still the questions are categorized as routine problems. Therefore, the relationship between the PERT mathematics scores and students’ problem-solving ability was considered a moderate correlation.

4. Conclusions
There is a linear relationship between the PERT mathematics score with students’ mathematics problem-solving ability. The correlation coefficient is 0.547 and $r^2$ is 0.299. Thus, it can be concluded that the students’ PERT mathematics score can explain about 29.9% of the total variation in students’ problem-solving ability score. This result shows that the linear relationship between the two variables is not strong enough. Other factors might explain about 70.1% of the total variation in students’ problem-solving ability score. The results of this research can provide valuable information on the direction of future research that may be required on the specific variables.

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